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ABSTRACT

A Rand evaluation of activity and products of gaming, model-building, and simulation carried out under the auspices of the Defense Advanced Research Projects Agency aimed not only to assess the usefulness of gaming in military-political policymaking, but also to contribute to the definition of common standards and the refinement of objectives for the entire gaming profession. As a result of the survey, the purposes, production, operation, use, and costs of 132 models, simulations, and games are reported. Recommendations are presented indicating several ways in which increasing professionalism can benefit both gamers and the policymakers they serve. (Author/RH)

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Models, Simulations, and Games— A Survey

Martin Shubik, and Garry D. Brewer

A Report prepared for

ADVANCED RESEARCH PROJECTS AGENCY

Rand
SANTA MONICA, CA. 90406

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PREFACE

In 1970 and 1971, Rand conducted a critical evaluation of the activity and products of gaming, model-building, and simulation, under the sponsorship of the Defense Advanced Research Projects Agency. The specific aim of that inquiry was to assess the usefulness of gaming in military-political policymaking. Its general aim was to contribute to the definition of common standards and the refinement of objectives that are necessary to the advancement of the gaming profession.

As part of that study, the authors, in cooperation with the U.S. General Accounting Office, developed and administered a detailed survey instrument to DOD personnel knowledgeable about a considerable subset of models, simulations, and games currently used in the DOD. This report describes the survey procedure, presents the results, and discusses their significance. (The GAO is independently analyzing the results.) The discussion covers the purposes, production, operation, use, and costs of the 132 models, simulations, and games surveyed. Respondents' opinions about several hypothetical innovations in the gaming profession are reported. The survey instrument is appended.

Based on their analysis of the survey results, the authors advance their own recommendations concerning the following aspects of the production and use of models, simulations, and games: advocacy versus scientific validation; costs; professional reviewing and standards; documentation; redundancy and standardization; clearinghouses; research needs; sizes of models, simulations, and games; free-form and man-machine gaming; and gaming in the civilian sector. Taken together, the recommendations indicate several ways in which increasing professionalism can benefit both gamers and the policymakers they serve.

Other Rand publications deriving from this research include R-620-ARPA, *The Literature of Gaming, Simulation, and Model-Building: Index and Critical Abstracts*, by M. Shubik, G. Brewer, and E. Savage, 1972, and R-732-ARPA, *Reviews of Selected Books and Articles on Gaming and Simulation*, by M. Shubik and G. Brewer, 1972.

Martin Shubik, a consultant to The Rand Corporation, worked on this project during the academic year 1970-1971, while on leave from Yale University, where he is Professor of the Economics of Organizations. A grant from the U.S. Office of Naval Research (contract N000-14-67A-0011) enabled him to stay at Rand through December 1971 to complete the work. Garry D. Brewer is a member of Rand's Social Science Department.

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I. INTRODUCTION

These little soldiers marching out
Could put the bravest foe to rout
And place the world beneath their sway;
But since their arms are rather light,
If I interpret it aright,
They're only setting out to play.*

CLASSES OF MODELS, SIMULATIONS, AND GAMES

Complex problems often demand complex analytic techniques: gaming and simulation are two such methods. Generally characterized as having not only intuitive appeal--based on nice descriptive properties--but also a solid empirical basis, these methods have stimulated the development of a large and expanding professional community and literature. What this community does, the trends and size of its activity, and where it seems to be headed are questions of importance.

Even after many years of work, it is still difficult to state with precision what is meant by gaming and simulation. What start out as games, for example, may degenerate into fruitless syntactic exercises. However, it is useful to distinguish four categories: analytic models, machine simulations, man-machine games, and free-form games.

Analytic Models

A good analytic model is usually quite abstract, poor in the number of variables explicitly considered but rich in ease of manipulation and clarity of insight. For many questions, the analytic model may give a single number for an answer, as contrasted with multiple, interrelated indicators of system behavior that may result from the use of other techniques. True, more than a single number, a kill probability or a specific survival level, for instance, may be of analytic interest. Frequently, however, a single end-state condition for a system is

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*Stanley Appelbaum, trans., "War," *Games and Pastimes of Childhood*, New York: Dover, 1969, pl. 26; originally published as Jacques Stella, *Les Jeux et Plaisirs de l'Enfance*, Paris, 1657.

calculated. This contrasts with the study of system behavior through time, in which end states may not be of interest or even relevant.

Certain forms of warfare have been characterized by game-theoretic, analytic models in which two-sided or more than two-sided combat is considered explicitly.* For example, one might wish to examine the optimal behavior of a red team versus a blue team when neither side's strategy is fixed. In a situation such as a two-sided war, one would think that assuming pure opposition would enable one to consider optimal tactics, and that deductions of an opposition's best strategy could lead to the formulation of optimal strategies. Unfortunately, it is generally not possible to do so. Combat situations more complex than simple tactical encounters are frequently not well represented as "zero-sum games" because they may not be situations of pure opposition. Furthermore, elements omitted from the analysis in the interest of tractability and precision (for example, "human factors") may be crucial to understanding what is in fact going on.

Good analytic models help spot the "chicken and egg" problem that, once recognized, can usually be solved. The point bears directly on the relationship among rigorous theoretical models, empiricism, and data gathering. An analytic model is usually too restricted to solve an actual operational problem directly. But because a model is normally clean and clear, it can warn about potential difficulties, indicate where additional measurements are most needed, and identify and order important omissions. This presupposes, of course, that those preparing the analytic models communicate with those who have the operational problem, and that their findings are received and understood.

The optimal-assignment method created by John von Neumann† is an excellent example of an analytic model that has limited interest for

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*For example, Melvin Dresher, *Games of Strategy: Theory and Applications*, Englewood Cliffs, N. J.: Prentice-Hall, 1961.

†John von Neumann, "A Certain Two-Person, Zero-sum Game Equivalent to the Optimal Assignment Problem," in H. W. Kuhn and A. W. Tucker, eds., *Annals of Mathematical Study*, No. 28, Princeton University Press, 1953, pp. 12-15.

direct operational application but that provides many basic insights. Assuming that one knows exactly what a man can and will do, that model considers a set of tasks that must be done and offers a way to assign men to tasks in an optimal manner. Though the simplifying assumptions may reduce the model's direct operational application and utility, von Neumann's work is clean and abstractly captures the core of an important problem.

Analytic work on the Berlin airlift provides an example where initially simple analysis yielded to more complex formulations as the problem began to be understood.* From the first linear program, the analysis evolved to dynamic models and ended up as a combination dynamic model and simulation. The evolutionary process was probably, in a strict pragmatic sense, optimal. One might conjecture that until the problem was "learned" with simpler, more abstract analyses, realistic representation was just not possible.

People most at home with analytic models include applied mathematicians, operations research analysts, and a breed that may be called "computerniks," although the computer is frequently used merely as an analytic aid.

Growth in the use and power of analytic models over the last 30 years has been astounding. In techniques, new insights, and amount of personnel, that growth has probably exceeded all previous work. The prospects are good for more diverse applications of analytic models and for increased use of the computer, not as a simulator but as an aid in solving analytic problems. The outlook is bright for serious model-building, problem-solving, and careful application. The status of and prospects for the three other categories are less certain.

Machine Simulations

In contrast with analytic models, machine simulations frequently involve many variables; many seem to make a fetish of "realism." Rationales for doing simulations are many and varied. One common and

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*A. S. Manne, *Allocating MATS Equipment with the Aid of Linear Programming*, The Rand Corporation, RM-1612, January 1956.

frequently valid reason is that mathematics is a relatively impoverished language, whereas the computer allows one to capture the richness or robustness of a real system. What is left unstated is the enormous price one is likely to pay to approximate that reality.

There are literally hundreds of machine simulations in the Department of Defense's current, active inventory. Most of them are force-structure, weapon-system, and technical-evaluation models.

Simulations and the people ("simulators") responsible for their design, implementation, and operation are much harder to control than analytic models or modelers. Not only are fewer scientific standards available to aid in evaluating a computer simulation than a mathematical model; there is little or no consensus among professionals as to what the proper standards are.

Promotion may well be the undoing of this potentially highly useful aspect of the profession. Large-scale computer simulations have been rather easy to sell. They appear reasonable, and they provide a wealth of material for impressive, high-level briefings. Advocacy or defense of a given system or point of view can be made to appear quite scientific.

Machine simulation has been oversold in the last ten years or so, and the shakedown is now taking place. The process is healthy, albeit painful in certain quarters. Much has been learned that contributes to the professionalization of work. Problems have been delineated, and lines of communication are being established. Still, practitioners must show more care in (1) modeling and specification, (2) data collection and validation, (3) sensitivity analysis and question formulation, and (4) accounting for costs and utilization. Each of these tasks is a challenge by itself. Together, they make the difference between a viable, useful simulation and something that is only useful to generate visual aids for high-level "dog and pony show" briefings.

Man-Machine Games

Man-machine exercises usually involve a digital computer and people playing some of the roles in the modeled system. People may be used merely because they are cheaper than the software. Or, people may

be used because human factors (particularly judgment) are important in the situation being analyzed.

In man-machine gaming and simulation, the personnel are usually analysts, systems engineers, experimental psychologists, social psychologists, and economists. In work emphasizing human factors, humans are studied, not merely used as inputs. With a systems-engineering emphasis, humans may be used because they are handy and relatively cheap. In that case, the orientation is more toward operations research analysis and systems engineering than it is to experimental or social psychology.

The former Logistics Simulation Laboratory at The Rand Corporation is an example of a man-machine simulation in which people were used more as an integral part of the machinery than as subjects for human-factor analyses.* John L. Kennedy's early work at Rand, on the other hand, is an example of human-factors analysis.†

Man-machine gaming and simulation was, at its peak of activity five to seven years ago, probably oversold. Currently it is undersold, if not totally neglected. What is needed is a basic inventory of information that stresses substantive content. The connection between machine-only simulations, human-factors analyses, and analytic models is slight, to their mutual detriment.

Free-Form Gaming

Free-form gaming involves teams and a referee group operating within the framework of a scenario. If computational equipment is used at all, it is often relegated to a simple bookkeeping role. Of the four classes, this one is the least amenable to tight technical control. It is, however, the most likely to produce an impressive array of new insights into complex problems.

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*M. A. Geisler and A. S. Ginsberg, *Man-Machine Simulation Experience*, The Rand Corporation, P-3214, August 1965.

†R. L. Chapman and J. L. Kennedy, *The Background and Implications of the System Research Laboratory Studies*, The Rand Corporation, P-740, 1955. See also N. Frederickson, "Factors in In-Basket Performance," *Psychological Monographs*, No. 22, 1962, for another good example of the genre.

Free-form gaming is also the least expensive. In fact, compared with the expenses associated with machine simulations and models, the costs of all other types seem minuscule. A familiar example of free-form gaming will suggest why and the way in which it is least costly.

The Political-Military Exercises at and for the Joint Chiefs of Staff's Studies, Analysis, and Gaming Agency (SAGA) are aimed at the strategic level and involve relatively high-priced personnel.* Strictly speaking, the cost of a game or simulation must include not only the price of the physical resources but also the value of the time of the personnel playing the game. In fact, the costs depend on how one evaluates the worth of the time of the top-echelon teams. But if personnel (and opportunity) costs are ignored, as is usual, all that a top-level political-military exercise needs are a couple of rooms, a few people (who are already in the Pentagon), some pencils, pads of paper, and a bit of videotape. Participants in the SAGA games may be Cabinet officials, three- or four-star generals, or admirals, yet the amount of money involved for the other resources is seldom more than $10,000 per game.

Though free-form gaming is the least tightly controlled and the least expensive type, it receives far and away the most publicity and is done at the highest policy level of all four types. Free-form gaming also has a few good practitioners and a product that is very hard to measure, making it extremely difficult to ascertain whether the art form has improved in the last few years. A little more money and some careful, rigorous work may yield some useful and productive results.

NONMILITARY APPLICATIONS OF GAMING AND SIMULATION

Before discussing our survey's findings about the military uses of models, simulations, and games, some observations on their general uses are in order. These remarks are limited to simulations or models that relate to competitive or cooperative behavior, that is, the behavior of more than one decisionmaker. Accordingly, studies such as the

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*For a clear introduction to this type of game, see Herbert Goldhamer and Hans Speier, "Some Observations on Political Gaming," *World Politics*, Vol. 12, 1959, pp. 71-83.

simulation of an oil refinery or transportation system are ruled out. Relevant applications fall into four main classes: industrial-operational, teaching and training, political-diplomatic-military, and research.

Industrial-Operational

We have found little use of gaming and simulation involving more than one decisionmaker in any civilian setting--in contrast to what articles in *Business Week*, *Fortune*, and *Harvard Business Review* suggest. While business games are frequently used in training programs, as entertainment for executives, and as teaching devices at business schools, the production and use of operational games by industry appear to be minimal.* Gaming for teaching purposes is particularly active: there exist about 500 business games, whose costs vary widely from a few thousand to hundreds of thousands of dollars. However, because of inadequate accounting, one cannot estimate the total investment or even the current operating costs for such activities.†

Teaching and Training

Recently there has been a spurt in the use of games for introductory teaching. At the level of university and adult education, the predominant type of game is the business game and its variants, which are usually computerized games. One class of such games relates to planning and development, including the land-use planning games CLUG, CITY, and METRO, and the air pollution exercise APEX. Intended to teach the management of urban development problems, these games have cost hundreds of thousands of dollars in total. The proliferation of games concerned with social problems such as congestion, pollution, and crime seems inevitable. Current funding for these activities is relatively modest, but the number and diversity of research proposals are growing.

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*Such activities doubtless exist as strictly proprietary ventures. The full scope and magnitude are, because of secrecy, probably unknowable.

†See Martin Shubik, "Gaming: Costs and Facilities," *Management Science*, Vol. 14, No. 11, 1968, pp. 629-660.

Political-Diplomatic-Military

Another type of gaming activity at the university or adult-education level is political-diplomatic-military gaming. It is typically of the free-form variety and relatively inexpensive. An upper bound on expenditures during the last 20 years is certainly no more than $2 million per annum, and probably much less. That crude estimate is guessed at from the budget of the political-military branch of SAGA, plus the budget of Harold Guetzkow's work on the Inter-Nation Simulation, plus a rough sum to account for various smaller activities such as the work by Lincoln Bloomfield at M.I.T., and political-diplomatic-military gaming at the war colleges, military academies, Rand, the Research Analysis Corporation, and a few universities. The amount of publicity given free-form, political-diplomatic-military games has been enormously disproportionate to the financial and intellectual investments in them. Popular accounts, such as Andrew Wilson's recent *The Bomb and the Computer*[*] aside, research on the intellectual foundations and uses of this type of work has been negligible.

Research

Gaming and competitive simulations devoted to research are concentrated in the universities, are associated with work in social psychology and to some extent with the formal theory of games, and are slowly increasing. Depending upon how the research is classified and costed, $2-5 million a year is probably being spent on these activities. Examples are the work of Anatol Rapoport and his associates, the work of Gerald Shure and Harold Kelley at UCLA, and the activities of the gaming laboratories at Berkeley, Purdue, Yale, Ohio State, and other universities. Specialized research agencies have used gaming as an adjunct to research. An important result of many of these games is the identification of key problems that are subsequently researched by other methods. A small amount of basic human-factors analysis is being performed by a few groups such as the Army's Behavioral Sciences Research Laboratories.

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[*] Andrew Wilson, *The Bomb and the Computer: Wargaming from Ancient Chinese Mapboard to Atomic Computer*, New York: Delacorte Press, 1968.

One could assign a certain percentage of the budgets for activities in the foregoing classes to research. However, it is practically impossible to figure the appropriate percentage, and there are strong indications that such research is not being undertaken.

Game Theory

One further topic is the role of mathematical, game-theory model construction in the study of conflict. In the United States a handful of professionals have specialized in the investigation of duels and allocation and search games.* This work is a mathematical art form that has added to the basic knowledge about competitive situations at a relatively low cost. These few professionals require no extraordinary equipment; hence, keeping them fully employed amounts to providing salaries and standard overheads. A liberal upper-bound estimate on total expenditures for such game-theoretic analyses of conflict situations is $1-2 million a year.

Summary

The major activities and expenditures in operational gaming and simulation to study conflict and cooperation are by the military. Such expenditures elsewhere are negligible. Expenditures for teaching-training gaming for university and adult education amount to no more than a few million dollars but are undoubtedly growing. Gaming in introductory education appears to be expanding as well. In research, experimental activity at the universities is increasing, but except for a few corporate-sponsored projects at places such as Rand and RAC, there appears to be very little direct funding of basic research elsewhere. That includes the military, except for a small amount of human-factors analysis.

Publicity devoted to gaming and simulation appears to vary inversely with actual expenditures and activities. High-level political-military exercises may have caught the imagination of the public, but they have

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*M. Dresher, J. Mayberry, S. Moglewer, L. Shapley, and several others come to mind.

not caught even a minute fraction of the total resources being devoted to gaming and simulation.

Professional interest and activity in gaming and competitive simulation is reflected in the membership of the Military Operations Research Society (MORS), which has some 4400 members on its current mailing list (down from a peak of about 5500 several years ago), and of the Institute of Management Science's College on Gaming and Simulation, which had a 1971 membership of around 650 (slightly larger than several years ago).

The growing literature is another indicator of activity. Of course, it shows a pronounced bias toward the nonmilitary aspects of gaming and simulation because military studies, even if they are not classified, normally do not appear in the published literature. Of the approximately 2000 articles and books that were investigated in the course of the authors' recent research, about 15 percent were operational and less than 12 percent were devoted to war gaming and political-diplomatic-military gaming.*

Historically it appears that activity and expenditures on gaming and competitive simulation hit a peak in the early to middle 1960s and have been on a gentle decline since then.

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*A survey and evaluation of the literature are contained in Martin Shubik, Garry D. Brewer, and Eve Savage, *The Literature of Gaming, Simulation, and Model-Building: Index and Critical Abstracts*, The Rand Corporation, R-620-ARPA, 1972, and Martin Shubik and Garry D. Brewer, *Reviews of Selected Books and Articles on Gaming and Simulation*, The Rand Corporation, R-732-ARPA, 1972.

II. THE SURVEY AND ITS RESULTS

Having ascertained that the major expenditures are devoted to competitive, all-machine simulations and models, considerably less to man-machine games, and the least amounts to free-form games, we identified approximately 450 active military models, simulations, and games of those types in several Department of Defense and service catalogs and inventories. In close collaboration with the General Accounting Office, which had independently been asked by the House Appropriations Committee to assess the kind, extent, and use of military gaming, we initially chose a sample of 150 models, simulations, and games, which number was later pared down to 135. A detailed, 70-page questionnaire* was circulated to the 135 groups, agencies, or individuals in DOD that were judged to be most knowledgeable about each model, simulation, or game.† We received 133 replies, one of which gave so little information that it was unusable. Thus, unless otherwise noted, the statistical material below is based on a respondent population of 132. Replies were coded for computerization (see the codebook, Appendix C), with multiple checks on the accuracy of transcription.

The sample was chosen to include several of the larger or more heavily used simulations and games. The sample was also biased somewhat towards the Army, there being 59 Army, 26 Air Force, 35 Navy, and 11 other DOD personnel in the population. Extrapolations from this sample to the total 450 models, simulations, and games should be made carefully, keeping these biases in mind.

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*Three preliminary versions of the questionnaire were developed and tried out on known games, utilizing cooperative and competent respondents. Our thanks to E. W. Paxson, J. R. Lind, H. Guetzkow, M. G. Weiner, and A. Theony for their constructive assistance with this critical portion of the research. The final version of the questionnaire was published as Martin Shubik and Garry D. Brewer, *Questionnaire: Models, Computer Machine Simulations, Games and Studies*, The Rand Corporation, P-4672, July 1971. It is attached as Appendix A, filled out with summary results of the survey, and serves as an organizing device for the body of this report.

†Appendix B provides a full list of the names of the models, simulations, and games surveyed in the preliminary and final stages of this project.

Total reported development costs were approximately $32 million, but approximately 30 responses did not provide appropriate or clear cost information. Tney included several of what are believed to be the larger simulations. Thus, by simple averaging, total costs approximate $40 million. Since the sample represents around 30 percent of the total inventory, a crude estimate of total investment is $130-$140 million for all active models, simulations, and games in the DOD inventory. Using other costing criteria before our questionnaire was circulated, the General Accounting Office made a preliminary estimate of $170.5 million,* which seems a plausible upper bound. On the average, the inventory represents a three- to four-year supply (an average model, simulation, or game "lasts" three to four years); hence we estimate that $30 to $40 million per year has been expended recently for construction costs. These estimates are of necessity very rough. In fact, one of our major findings concerns the poor to nonexistent cost-accounting definitions and procedures.

The size of expenditures and number of activities do not provide all the clues to the importance of the work. Many other criteria are needed to judge these activities. But valid criteria have not yet been formulated for the profession. With these caveats in mind, let us turn to a broad description of the survey results.

THE RESPONDENTS

When the final version of the questionnaire was set, the General Accounting Office met with personnel at DOD "points of contact," described the rationale of the survey, and asked that the most knowledgeable person about any given model, simulation, or game be assigned to answer each questionnaire. If one person could not do it, groups or committees were acceptable substitutes as long as the responses were the most up-to-date and accurate possible.

As it turned out, most questionnaires were filled out by one person, and most respondents filled out only one questionnaire. In a few

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*U.S. General Accounting Office, *Computer Simulations, War Gaming and Contract Studies*, A Report to the Committee on Appropriations, House of Representatives, Washington, D.C., February 23, 1971, p. 8.

instances, one man was responsible for two or perhaps three separate entries. One respondent did yeoman service on six or seven questionnaires.

Respondents were mostly users, 42 or 31.8 percent, or designer/builders, 41 or 31.1 percent. The next largest classes of respondents were funder/sponsors, 19 or 14.4 percent, and caretakers, 13 or 13.6 percent.*

The average length of time required to fill out the questionnaire was 10.5 hours. The modal time was 4 hours, and 84 were able to answer in 8 hours or less; however, two or three respondents stated that they took as much as 70 hours.†

One might thus presume that this group of respondents would be able to provide, as well as or better than any other group that might be formed, reasoned and valuable replies to the questionnaire. The following pages discuss their replies, grouped under the headings purposes, production, operations, use, and costs of models, simulations, and games, and their opinions about certain hypothetical innovations in the gaming profession.

PURPOSES

Because there is so little agreement even about fundamental definitions, it seemed especially important to find out what terms and concepts the professional community is currently using to describe the rationale or intent of various models, simulations, and games.‡ The intention or purpose for which an MSG is built has a direct and important bearing on how one subsequently goes about specifying, validating, and controlling it.

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*The name, affiliation, and address of each respondent have been coded and included in the data; however, that information is not reported here.

†Reported time to complete each questionnaire is listed in Appendix B.

‡For convenience, the authors have expressed the notion of model, simulation, or game as "MSG," which term is used hereinafter.

Basic Categories

We began by asking each respondent to identify his MSG as either a model, simulation, a man-machine or manual game, a mathematical analysis or study, or, if none of those categories fit, as an "other." Results are shown in Fig. 1. Most were identified as models. The usage of that term and concept is vague, however; one respondent noted that to him a model meant any regression equation, therefore the universe of models is so large as to be virtually unbounded. In short, the word has little referential utility. The terminological problem is underscored by the General Accounting Office's initial lack of success when it asked the military services to provide data on "war games." The GAO found that practically no war games are played; rather, models and simulations are built.

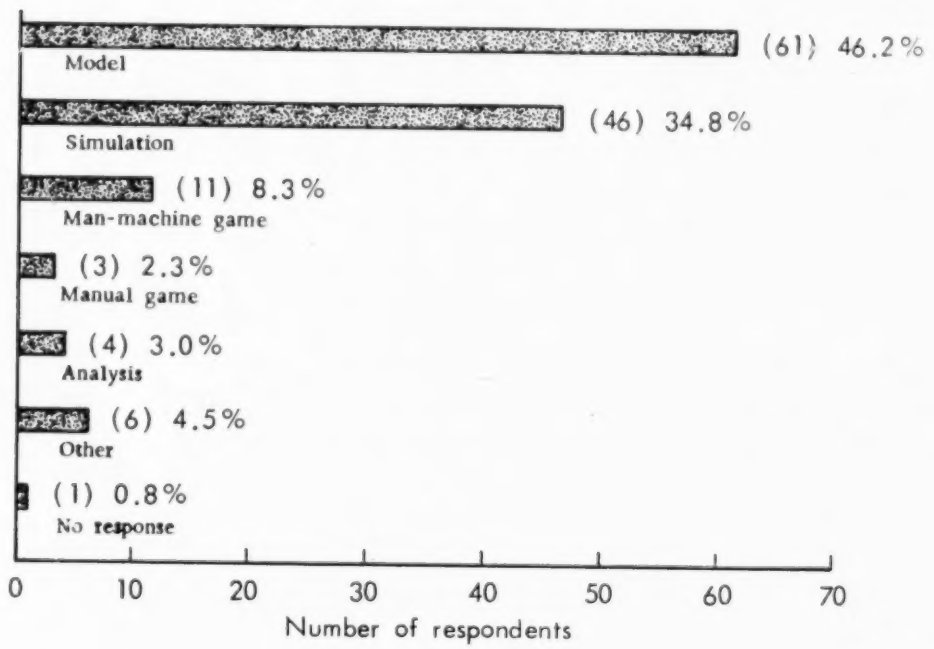

Fig. 1—Respondents' primary classification of their MSGs (variable CATEG 1)*

*See Appendixes A and C for complete definitions of all variables.

Another striking finding is how few man-machine and manual exercises are in the DOD's active inventory (14 or 10.6 percent). While our sample represents 132 of the some 450 active MSGs, we are reasonably confident that 10.6 percent is an accurate estimate of the current low level of man-machine and manual (or free-form) activity.

Multiple choices were allowed; that is, a respondent could call his MSG both, say, a model and a man-machine exercise. However, only 26 indicated a secondary choice, and of that subset, 19 chose simulation, 3 "other," and 2 each models or mathematical analysis. No one selected as a secondary choice man-machine or manual game.

Concepts and Questions

The important concept of purpose is inherently complex. Accordingly, our probings were detailed and intentionally redundant. Respondents were asked to describe in their own words the major stated purpose of their MSG and to cite two specific questions or operational problems that the MSG had been used to answer. Next, they were asked to check off appropriate characterizations of purpose from a list of eight categories, one of which was "other--specify." We also asked them to indicate their confidence in that response, from low to absolutely certain. Several questions later, purpose was brought up again, with reference to who had initiated the work, what he wanted, and how well he specified his wishes. And finally, several questions later, we asked simple yes-no questions about whether the MSG was initially designed for experimental or educational purposes. The results of this repeated probing are revealing, especially when tabulated with other descriptive categories such as who paid for, built, or used the MSG, at what cost, and so forth.

Results

Description.* Primary purposes are shown in Fig. 2. No respondent

*For a theoretical examination of purposes, see Martin Shubik, *On the Scope of Gaming*, The Rand Corporation, P-4608, March 1971, republished in *Management Science*, Vol. 18, No. 5, January 1972, Part 2, pp. P-20-P-36.

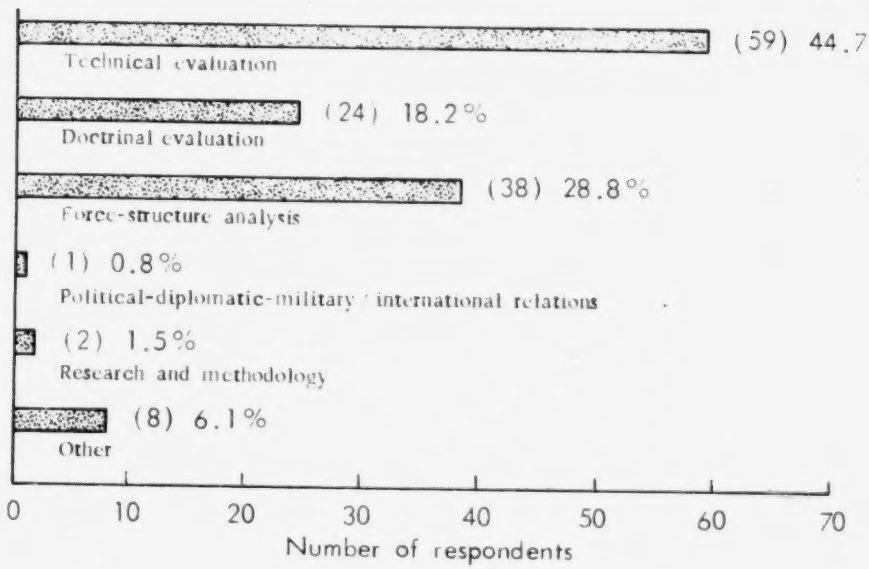

Fig. 2—Primary stated purpose of MSG (variable PURP1)

indicated that his MSG was intended primarily for military-political-economic and training/education purposes. In fact, only one MSG was listed under political-diplomatic-military (abbreviated PDM)/international relations. Given present-day concern over strategic arms limitation, perpetual Middle East tensions, and the expansion of Sino-American relations, that is a startling finding. Even when secondary and tertiary purposes are taken into account, the findings are not much different. Some 61 or 46.2 percent of the MSGs had only one purpose, and of the remainder, one each had secondary purposes of PDM/international relations and training/education. Of the MSGs with three purposes (36 or 27.3 percent), two were military-political-economic and one each was PDM/international relations and training/education. Research/methodology received similar scant attention. It was the primary purpose of 2 MSGs, the secondary purpose of 5, and the tertiary purpose of 10.

By far the greatest emphasis in current DOD activity is on all-computer, technical evaluations (59 or 44.7 percent), force-structure analysis (38 or 28.8 percent), and doctrinal evaluation (24 or 18.2 percent). When it comes to secondary purpose, the mix changes. Of the

71 MSGs with more than one stated purpose, 32 were intended to study doctrine, 28 for force structure, and only one for technical evaluation. At the tertiary level, with 36 reported, 17 were for force-structure analysis, 10 were for research and methodological development, and the remainder were sprinkled among other purposes.

Technical evaluation turns out to mean weapon system evaluation when one reads the written accounts of each MSG's major stated purpose and examples of use. Such activities are appropriate enough, but only if the data are valid, are available for scrutiny by responsible persons, and if scientific criteria and procedures such as replication, external review, and documentation are followed. If such rigor is not assumed, one suspects that much effort is going into building unevaluated MSGs that support specialized points of view. The scarcity of attention given research, training, and more-or-less "political" matters could lead one to believe that the DOD is modeling problems that are easily quantified and are well enough understood that no new theoretical research is needed to explain them. If so, then either the problems confronting the DOD are in fact being managed in a rigorous, scientific fashion, or, as appears to be the case, intangible, intractable, or "soft" issues are largely being overlooked.

Respondents were generally highly confident or absolutely certain about their MSG's purpose (105 or 79.5 percent).* However, 27 or 20.5 percent either had low to moderate confidence in their answers or did not respond at all. Considering the composition of the respondent population and the inquiry's intent and sponsorship, that figure seems inordinately high. If these people do not know what their models are supposed to do, who does?

Initiators of MSG development, as shown in Fig. 3, strongly favored analysis and diagnosis as a primary purpose (108 or 81.8 percent). Far fewer favored operations (14), research and theory development (7), experimentation (1), or teaching-training (2). That finding is consistent

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*Confidence levels, the degree of the respondent's certainty about an answer, were required on most questions. The categories ranged over low, moderate, high, to absolutely certain, assigned values 1 through 4, respectively.

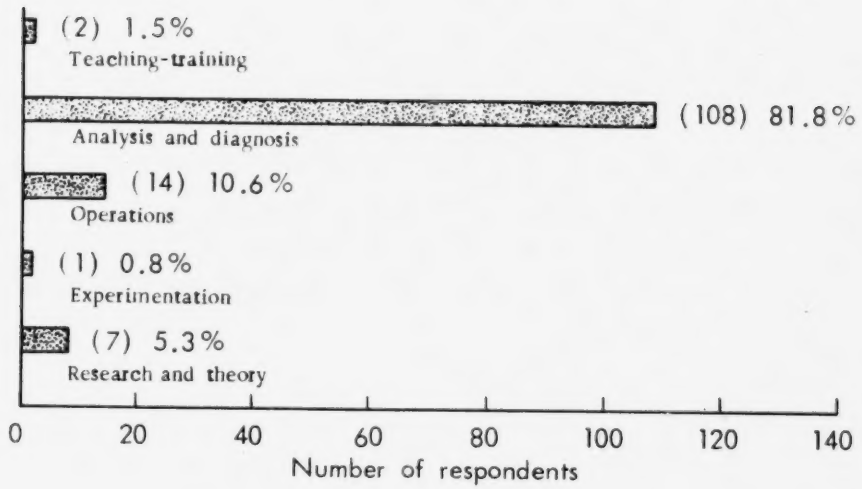

Fig. 3 — MSG initiator's primary purpose (variable INPURP1)

with the heavy emphasis on technical evaluation and force-structure analysis already observed. When asked how tightly funding sources specified their intentions or purposes, 77 respondents replied with either high or absolute certainty that 33 or 25.0 percent of the sample were tightly specified, that is, the funding source defined well what it wanted for its money. In 26 or 19.7 percent of the cases, however, the respondent either did not know or did not respond to the question. Those replies are shown in Fig. 4.

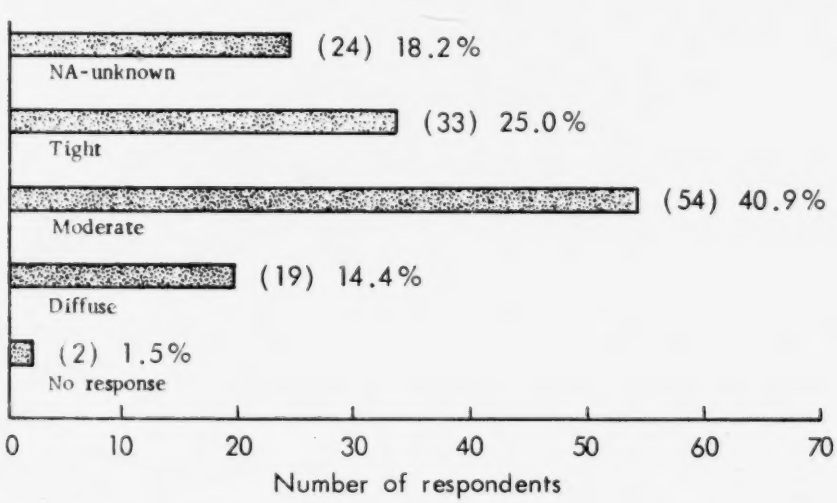

Fig. 4 — Specificity of initiator's purpose (variable SPCPRP)

A full 114 or 86.4 percent of the MSGs were not intended for experimental purposes, and 121 or 91.7 percent were not intended to be used for educational purposes. The sample may be tentatively characterized as operational machine models and simulations used for technical evaluations and force-structure analyses. Research, experimentation, and training and education are all of considerably less importance in this sample.

Trends. Fundamental purposes have shifted somewhat for MSGs initiated since 1966. Of all MSGs produced, technical evaluations have declined somewhat, from 50.0 percent for 1966-67 to 38.9 percent for 1971-72; force-structure analyses have increased from 13.6 percent to 38.9 percent; and doctrine evaluations have remained rather steady at about 22.0 percent of the total.

Since 1966, not a single one of these MSGs was initiated for teaching and training purposes. Analysis and diagnosis as a purpose has held steady at about 85 percent of the total initiated.

Relationship to Other Descriptors. Respondents knew in general what their MSGs were supposed to do, as indicated when primary purpose was cross-tabulated against the respondent's confidence in his reply. Some 89.5 percent were either highly or absolutely certain about purpose; however, 10 of the 38 force-structure MSG respondents indicated low or middle confidence or did not bother to answer at all [X^2 $p < .024$]. The reason is not clear, but a possible explanation is that force-structure MSGs are not well documented or are "one-shot" affairs whose initial purpose is no longer remembered by the organizations responsible for them. We shall reexamine that hypothesis later.

Looking at the MSG funding source indicates that the Navy concentrates heavily on technical evaluation, 26 out of 33 or 78.8 percent; the Air Force divides between force-structure analysis, 12/23 or 52.2 percent, and technical evaluation, 10/23 or 43.5 percent; the Army is evenly divided between technical evaluation, 18/56 or 32.1 percent, doctrine evaluation, 16/56 or 28.6 percent, and force-structure analysis, 16/56 or 28.6 percent; and 5 of the Joint Chiefs of Staff's entries were on force structure and one was on PDM/international relations [X^2 $p < .001$]. No direct Department of State or National Security Council

funding was noted, reinforcing an earlier observation about the sample's apparent dearth of explicitly political or diplomatic substance.

MSG initiator cross-tabulated with purpose requires some explanation. Model-builders or researchers may as individuals propose MSG construction to an appropriate funding source. That differs from in-house work, which is limited either by the eventual users or by a non-user management source acting for the users. An agency outside an organization may request an organization to build an MSG for its use, or an agency may request a different organization both to build and use an MSG for the initiator's own purposes. Individual researchers initiated 24 or 18.2 percent of all 132 respondent MSGs, and of those there was a fairly even division between technical, doctrinal, and force-structure evaluation, and analytical purposes. Of the 40 MSGs initiated by in-house users, 18 or 45.0 percent were for technical evaluation. That, plus those initiated by users external to the building agency, accounts for 34/59 or 57.6 percent of all the technical-evaluation MSGs. Thus, it appears that users tend to initiate their own technical-evaluation MSGs [X^2 $p < .011$].

The initiator's purpose, whether teaching, analysis, operations, experimentation, or research, when tabulated against the MSG's purpose or category of intended use, shows that the penchant to do analysis and diagnosis runs evenly through all MSG purposes. For technical evaluation, 50/59 or 84.9 percent are intended for analysis and diagnosis; for doctrine evaluation, it is 21/24 or 87.5 percent; and for force structure, it is 30/38 or 78.9 percent [X^2 $p < .001$]. The one surprising finding is that when an initiator intended research and theory development (7/132 or 5.3 percent), it resulted in MSGs whose primary purpose was technical evaluation (4/7), force-structure analysis (2/7), or doctrine evaluation (1/7), not the development of research or methodology [X^2 $p < .001$]. It appears that even when one has a serious research problem, the resulting MSG is not reported as being primarily geared to research. As for the two MSGs whose prime purpose was listed as research and methodology, initiators intended analysis, diagnosis, and experimentation, not research per se [X^2 $p < .001$].

Two descriptive classes of information, the ease of transfer of MSG operations from one site to another and the extent of documentation, provide insight into the adequacy of scientific controls.

Technical-evaluation MSGs do not transfer at all in 15.3 percent of the 59 cases; transfer with great expense in time and technical talent in 22.0 percent of the cases, and are easily transferable in but 8 of the cases, or 13.6 percent of the time. The relationship between purpose and ease of transfer was not statistically significant, so we are unable to place too much confidence in what the descriptor means. However, the tabulation of purpose versus extent of documentation was highly significant [X^2 $p < .001$] and suggestive. By the respondent's own assessment of documentation, which we found to be overgenerous in several cases where documentation was probed in detail, 15 of the technical-evaluation MSGs had either weak, poor, uneven, unavailable, or unknown documentation. Of the 38 force-structure MSGs, 9 fell into those categories. That information is not conclusive, however, because roughly equal numbers in each category responded that their MSG had excellent, very good, or average documentation. While the distributions are flat, the fact that 25.4 percent of the technical-evaluation and 23.6 percent of the force-structure MSGs were voluntarily acknowledged to have weak or worse documentation seems important.

Cost data were broken down into coded categories and were tabulated against purpose. Immediately one is struck by the fact that 25 or 18.9 percent of the respondents were unable to supply any information whatsoever on costs. Of the remainder, 50 MSGs cost $100,000 or less, 22 cost $100,000-$249,000, and 17 cost $250,000-$500,000. Of the 18 MSGs costing more than $500,000, 6 were technical evaluations, 5 were doctrine evaluations, 5 were force-structure studies, and 1 was for political-diplomatic-military purposes [X^2 $p < .012$]. Later we shall take up cost considerations in more detail.

PRODUCTION

Under "purposes," several basic questions were asked about the MSG's production. It is an important topic that warrants analysis by itself, so we later posed more detailed questions, such as how many

predecessors and spinoffs are traceable to the MSG; how long it was under development before being used; how many man-years were taken to build it; and where the data came from to specify it. Another set of questions asked respondents to describe and characterize the MSGs that resulted from the production process.

Concepts and Questions

While some production questions, such as what MSGs preceded or followed the investigated MSG, are straightforward and easily answered, others are not.

When discussing development time, for example, it is difficult to be both precise and accurate. We refined the question to include the *elapsed time* between the decision to build a given MSG and its first production run, thereby grossly underestimating in those cases when an MSG continues to be developed even while it is being used. Another illustration of conceptual difficulties is the estimation of human resource expenditures. One must distinguish between total man-years, professional man-years, and programmer man-years to understand what kinds of talent have been involved in MSG construction.

To understand the sample better, several descriptive questions about scenarios, mathematical difficulty, timing, levels of resolution, use of random events, and supporting data were asked. Taken together, they provide valuable insights into current production practices.

Results

Description. About three-fourths of the sample had at least one direct parent or antecedent MSG, indicating the cumulative, continuous nature of much of the work. While the sample was biased to include many active MSGs, there were 45 cases where a spinoff or distinct progeny was reported to have been developed. These activities are clearly not discrete events but represent a continuous, ongoing process of initiation, production, and use.

Alternative procedures or methods to the one chosen were elicited by asking the respondents to imagine achieving the objectives of the MSG by different means. As shown in Fig. 5, analysis was the dominant

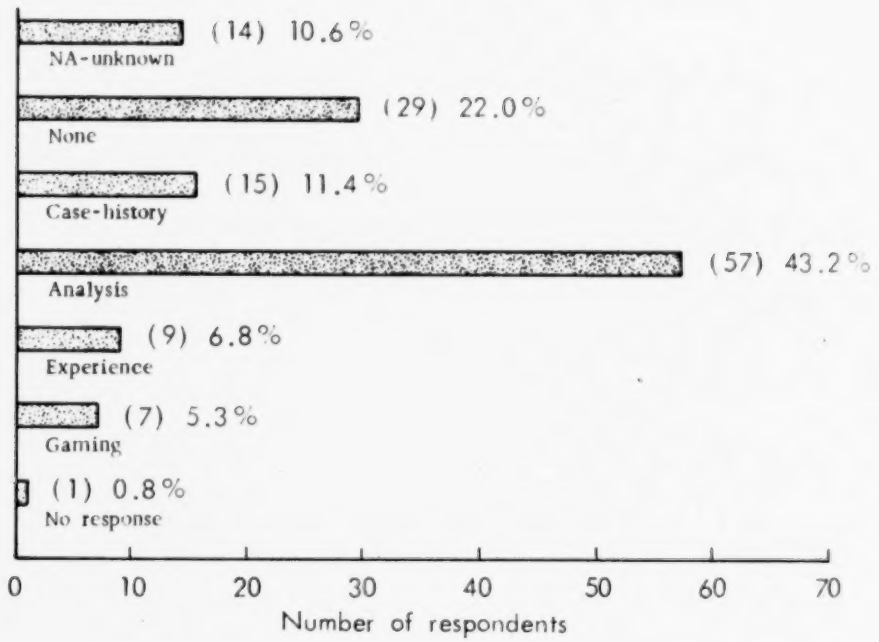

Fig. 5— Best alternative method to one used (variable ALTPRO 1)

alternative, reinforcing an earlier observation on the widespread use and acceptance of the term "analysis." The fact that 22.0 percent of the respondents believed that no alternatives existed supports the view that much of this activity is of a "last-resort" methodological variety: many of the problems are not tractable by other means.

MSGs were constructed largely by the armed forces themselves, 59 or 44.7 percent of the entire sample. For-profit organizations built 37 or 28.7 percent; not-for-profits contributed 29 or 22.0 percent; and universities accounted for 7 or 5.3 percent.

Development time, the elapsed time between initiation and the first production run, varies widely between less than three months to more than 42 months. The distribution is shown in Fig. 6. Since 63.6 percent were developed in 18 months or less, one might conclude that decisionmaking lead times are most likely to run under two years. It took two to five man-years to develop 31.8 percent of the sampled

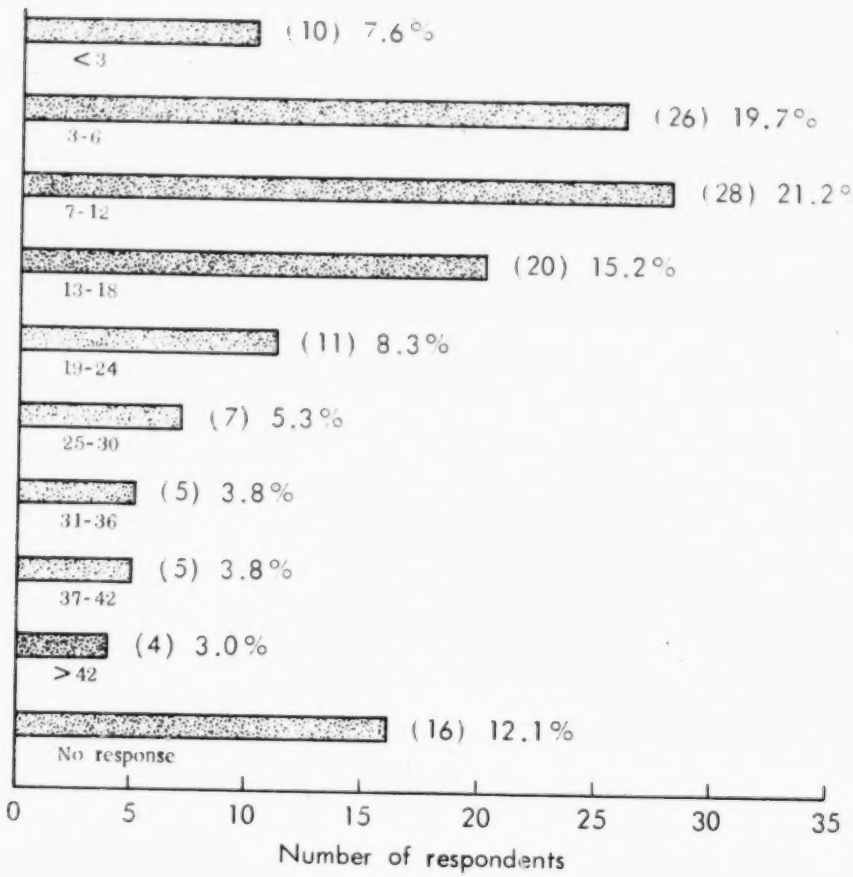

Fig. 6 — MSG development: Elapsed time (months) from initiation to first production run (variable DEVTM 1)

MSGs. Less dominant categories are depicted in Fig. 7. Professional man-years and total man-years are nearly equivalent, suggesting that most development activity was carried out by professionals themselves. Indeed, written profiles of professional teams support this point nicely. About one computer programmer man-year per MSG was the norm.

Our next set of questions dealt with a characterization of the MSGs and their data bases. A quick summary of the findings revealed that 54 percent used numerical scenarios only. Judging from the analysis and written replies to the questionnaire, little attention appears to be paid to intangible assumptions or to qualitative factors in the studies.

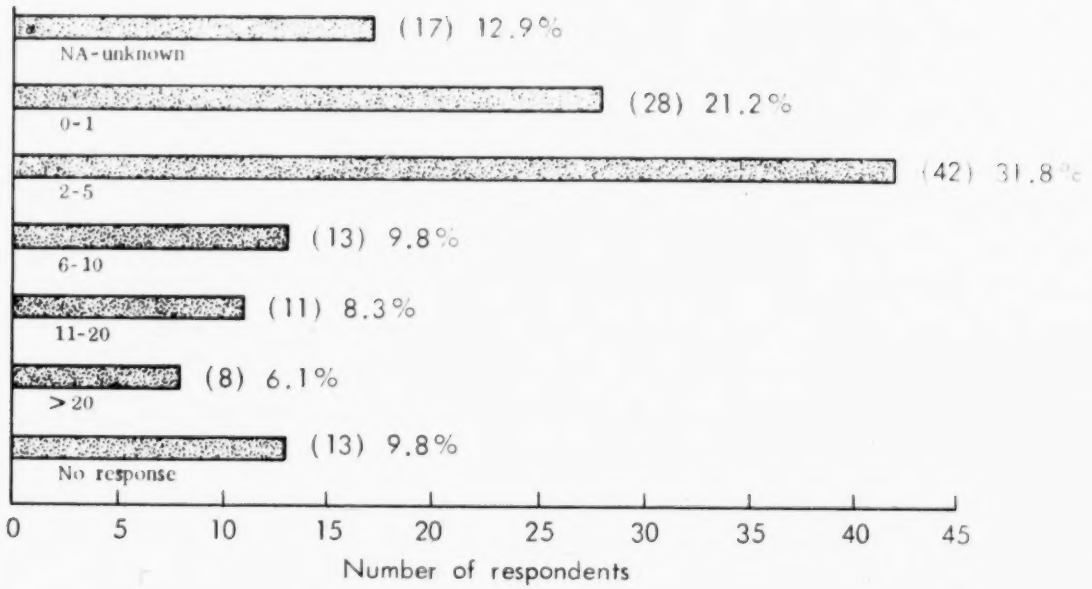

Fig. 7— MSG development: Human resource expenditures (man-years) (variable DEVMY1)

In spite of a popular belief that "advanced mathematical methods" are taking over, the level of mathematical sophistication required to work with the MSGs was regarded as high ("requires an advanced degree to interpret the output") in only 8 percent of the cases.

Most MSGs, 52 percent, had as their time setting either an unspecified time or the future.

Of all the MSGs, approximately 45 percent were directed toward the study of combat at the engagement level, 10 percent at the battle level, 11 percent at the campaign level, and 14 percent at the level of war.

The level of temporal resolution was rather small. Fully 79 or 66.8 percent were detailed down to either minutes or seconds. Similarly, spatial resolution was also fine-grained; about 35 percent were based on meters, and some 27 percent were detailed at the kilometer level.

The sample was split about 50/50 on the use of random elements.

We were surprised, given the quantitative and qualitative advances in computer languages, that so many MSGs were still written in FORTRAN--more than 80 percent. The remainder were spread widely among SIMSCRIPT, ALGOL, ASSEMBLY, COBOL, GPSS, and several others.

On the question of MSG size, we asked for the approximate number of computer instructions contained in the model itself, less any data inputs. On the average, they are either very large (36 or 27.3 percent had over 10,000 instructions) or moderately small (24 or 18.2 percent had 2,000 or less); 45 or 44.0 percent contained less than 4,000, or about two boxes of IBM cards.

In spite of our difficulty in getting information about these MSGs, 72 percent were unclassified as long as data input values were not attached. With input data, only 12 percent were still unclassified. Data are classified predominantly at the Secret level. Thus, there is little reason for classification to prevent most of the sampled MSGs, at least, from being made available for scientific scrutiny.

There is an indication that data-source and validity problems are acute. Careful gathering of field-test data or experimental information tends to be expensive and time-consuming, especially the preparation of planning factors; few of these MSGs benefited from such measures. The modal procedure is to have other military agencies supply data without any follow-up or cross-checking by the user agency. In less than 30 percent of the replies was there any indication that additional effort had been made to check the validity of the data.

Trends. Of MSGs developed since 1966, development time has fluctuated so that no clear trends are apparent. There is a slight trend toward fewer technical evaluations and more force-structure analysis; doctrine evaluations have been relatively stable.

The technical characteristics of MSGs are all quite stable. That is to say, there are no discernible changes in the proportion of numerical versus verbal scenarios being used, in the level of mathematical sophistication being "built into" the MSGs, in the level of temporal resolution, or in the split between those using and those not using stochastic or random elements.

Relationship to Other Descriptors. Of the 59 MSGs constructed in-house, 31 were for the purpose of technical evaluation, 17 were for force-structure analysis, and 8 were doctrine evaluations. Of those built by for-profit organizations, 11 each were technical evaluations and force-structure analyses, and 8 were doctrine evaluations. Not-for-profits built 11/29 or 37.9 percent for technical evaluation, 10/29

or 34.5 percent for force-structure analysis, and 8/29 or 27.6 percent for doctrine evaluation. Universities concentrated 6 of their 7 MSGs on technical evaluation. Of the 2 research MSGs, 1 was done by a university and 1 by the armed forces [X^2 $p < .007$].

Multiple authorship or participation in the construction phase was noted in 17 instances. Not-for-profits did 11 of them, mostly on a piecemeal or consultative basis, and 8 of those were for technical evaluation purposes. The remaining 6 multiple-author MSGs resulted when several agencies of the same armed force contributed significantly to one final product [X^2 $p < .016$]. It appears that the not-for-profit firms are occasionally utilized to back up in-house, armed forces construction activities. Given the scope, magnitude, and cost of many of these MSGs, the extent of multiple authorship is less than we had expected. In fact, it may be a manifestation of what appears to be a harmful compartmentalization and overspecialization in activity.

When the military service responsible for an MSG is tabulated against a range of construction-related descriptive variables, the following patterns emerge:

Construction and purpose: The Army is rather evenly split between the three purposes of technical evaluation, doctrine evaluation, and force-structure analysis; the Air Force is doing more force-structure analysis, 50.0 percent, and technical evaluation, 42.3 percent, than doctrine evaluation, 7.7 percent; and the Navy is largely constructing technical evaluations, 77.8 percent, to the exclusion of other types [X^2 $p < .0001$].

Initiation: Navy MSGs are initiated either by external users or by the builders themselves to a far greater extent than in the other services. The Army accounts for 11 of the 17 or 64.7 percent of the external, non-user initiations. No particular pattern is discernible for the Air Force; that is, initiation comes from a variety of sources [X^2 $p < .03$]. There is also no observable pattern in Air Force specification of the purposes of its MSGs. The Army, on the other hand, accounts for two-thirds of those that are tightly specified. The bulk of Navy work was noted as being "moderately" specified [X^2 $p < .002$].

Construction site: While not significantly related [X^2 $p < .15$, n.s.], on a percentage basis the Air Force does more of its own work in-house than do the other services; the Army uses for-profits more than expected and more than the others; and the Navy's involvement with Johns Hopkins University makes it the dominant university user.

Development: As noted, about two-thirds of the sampled MSGs were developed in 18 months or less. The Army accounted for 21 of the 36 MSGs built in 6 months or less. Navy construction apparently normally takes from 6 months to a year, while no distinct pattern is evident for Air Force construction. Likewise, at the other end of the scale, no one service stands out as taking particularly long to develop its MSGs [X^2 $p < .05$].

Data sources and validity: Navy data, as indicated by the respondents, are most likely to have been cross-checked, field-tested, or experimentally derived, 27/36 or 75.5 percent. For the other services, it was about a toss-up as to whether data were checked or not. MSGs built at or for the Joint Chiefs of Staff were about three times as likely *not* to have their data checked as were all others in the sample; in fact, in 10 of 11 "other DOD" MSGs the data were not cross-checked, were unknown, or no response was given. Validation procedures were not significantly service-specific, although no less than 38 or 28.8 percent of the entire sample reported that validation was not undertaken, was unknown, or gave no response.

Data type: We asked what predominant type of data were used, whether hard, moderate, soft, or combinations. Examples of each of three basic types were provided. Only 8 used mainly soft data or soft data in combination with numbers of greater certainty, a point already noted. Generally, Air Force MSGs used hard data to a greater extent than did those of the Navy or Army [X^2 $p < .01$].

Construction and security classification: If an MSG without data inputs was classified at all, and about one-fourth were, it was most likely at the Confidential (17/37 or 46.0 percent) or For Official Use Only (9/37 or 24.3 percent) level. More Army MSGs are unclassified (81.4 percent) than Air Force (69.2 percent) or Navy (64.0 percent) [X^2 $p < .01$]. When data inputs are added, a full 85.6 percent of the

entire sample becomes classified, mostly at the Secret level (78 or 59.1 percent). On a percentage basis, the Air Force at 92.3 percent has more classified MSGs than expected on the average for the entire sample, and more than either the Navy or the Army [X^2 $p < .002$].

Size of MSG: The bimodal distribution noted for the whole sample held for the individual services with only minor variations; the Navy at 33 percent, on a straight percentage basis, had more MSGs in the largest size category (> 10,000 instructions) than did either the Army (28.8 percent) or the Air Force (19.2 percent). Most Air Force entries were in the 1,000-2,000 instruction range, 9/26 or 34.6 percent. If Army MSGs were not large, and 17/59 were not, they were in either the 2,000-4,000 or 4,000-6,000 range (both 8/59 or 13.6 percent) [X^2 $p < .001$].

Levels of MSG resolution: The Navy is building more of its MSGs at a finer level of temporal detail than are the other services; *all* are cast either in seconds (22/36 or 61.1 percent) or minutes (8/36 or 22.2 percent), with the remaining 6 not answering [X^2 $p < .001$]. The Army builds most of its MSGs at the level of spatial detail of the kilometer, the Navy at the meter level, and the Air Force shows no clear preference. In keeping with the fine grain of much of the sample, most MSGs were cast at the engagement level. Battles, campaigns, and wars, increasingly large levels of resolution for military activity, are mainly the province of the Army, which accounts respectively for 85.7 percent, 40.0 percent, and 61.1 percent of the activity in each [X^2 $p < .001$].

When MSG category was tabulated against the ratio of model time to real time, a technical concept measuring the extent of time compression or expansion, a full 30.3 percent of the respondents either did not know or failed to answer. Of the remainder, if an MSG compressed time extremely, it was probably a simulation; real-time representations were fairly evenly divided among the categories; and expanded MSGs were man-machine exercises or models [X^2 $p < .03$].

The smallest MSGs, those having fewer than 1,000 computer instructions, were models about 73 percent of the time. More than half of the man-machine exercises were in the largest size category, 54.5 percent, while only 33 percent of the simulations and 21 percent of the models were as large [X^2 $p < .02$]. We looked at the incidence of intangible

assumptions and MSG size and found that for the largest category, intangible assumptions were made nearly 20.0 percent more than would be expected for the whole sample [X^2 $p < .001$].

OPERATIONS

Questions related to MSG operations dealt with two broad matters: scientific standards and technical-procedural issues.

Concepts and Questions

Of major concern was what testing and professional controls were employed to insure MSG fidelity. Questions such as whether sensitivity testing was carried out, whether the operations of a given MSG could be transferred to a comparable location elsewhere, and whether an independent professional review had been carried out are examples of our operational control questions. Questions about the MSG's need for special facilities, languages, or documentation pertained more to techniques and hardware.

Results

Description. Sensitivity analysis is an important operational control, especially when the number of variables is large and the model complex. One must find out about an MSG's behavior as sets of input parameters are altered in interesting ways. Without sensitivity analysis, one cannot know much about the MSG's performance. In our sample, 45 percent indicated that their MSG had not been sensitivity-tested. Granted, such testing is generally expensive and time-consuming, but it is essential to a determination of the MSG's usefulness and validity.

We have already touched on the topic of data validity. Probing a bit more, we found that about 14 percent used several generally acceptable and commendable means of checking on the accuracy and quality of input data. In about 28 percent of the cases, less thorough measures were taken, because questions remained about the precision of some numbers actually being used. For 30 percent, the written commentary combined with categorical assessments indicated that the issue was at least considered and some effort made to check out the data. Data validation

was not attempted in 16 percent of the cases, and a full 13 percent either did not reply or did not know about the matter.

Documentation is a prime control function that has received inadequate attention. Figure 8 gives a clear portrayal of what appears to be the optimistically biased self-assessments of most respondents. These assessments would be more believable if they had been put to, and had passed, an operational test. In fact, as shown in Fig. 9, only 18.2 percent of the MSGs were generally transferable. The importance of replication is both scientific and administrative. If a model cannot be transferred, independent reviewing is more-or-less precluded. The administrative issue is the obvious one of controlling redundancy; some 52 percent of the respondents indicated that they were not aware of any closely related MSG, and approximately 4 percent did not reply at all. But that is of little consequence because nearly half the respondents, as depicted in Fig. 10, did not know what it would cost to transfer operations.

Responses indicate that nearly half the MSGs had not been subjected to review outside the building-user organization. The actual figure is probably higher, since this sample is biased toward Army models, which probably have benefited from the recent ad hoc Army Model Review Committee's* efforts to increase the outside professional review of MSGs. At best there is less than a 50/50 chance that any active model in the inventory has been reviewed. The date of most recent review is suggested in Fig. 11.

Special facilities of one variety or another were required for about a third of the sample. About 16.6 percent needed dedicated computational systems, 13.0 percent used specialized languages or libraries, and 2.3 percent required special buildings or laboratory facilities. MSGs should be made more transferable than they are: there are few valid technical obstacles to replication.

Trends. There has been a significant decline since 1966 in the incidence of external professional review, in spite of the recent ad hoc Army initiatives. Percentage data are summarized in abbreviated form in Table 1.

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*Chaired by Dr. J. Honig at the request of Lieutenant General William E. DePuy, U.S. Army.

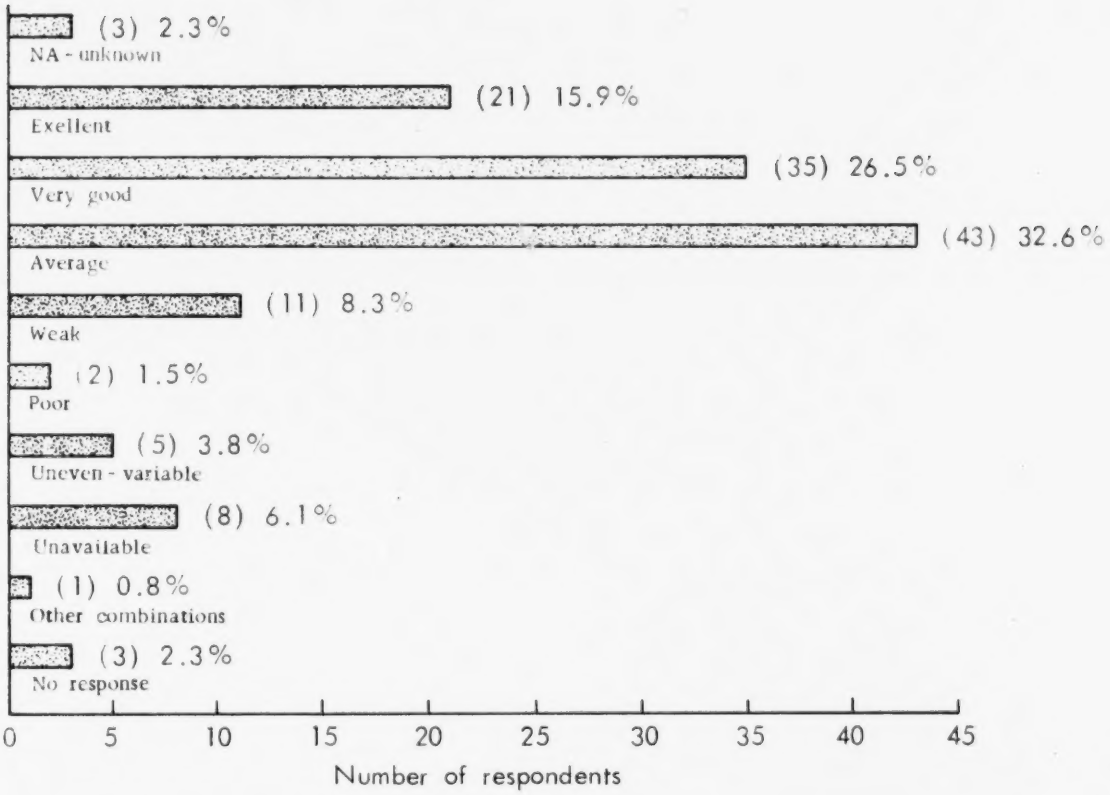

Fig. 8—Quality of MSG documentation: Respondents' assessments (variable DOCEXT)

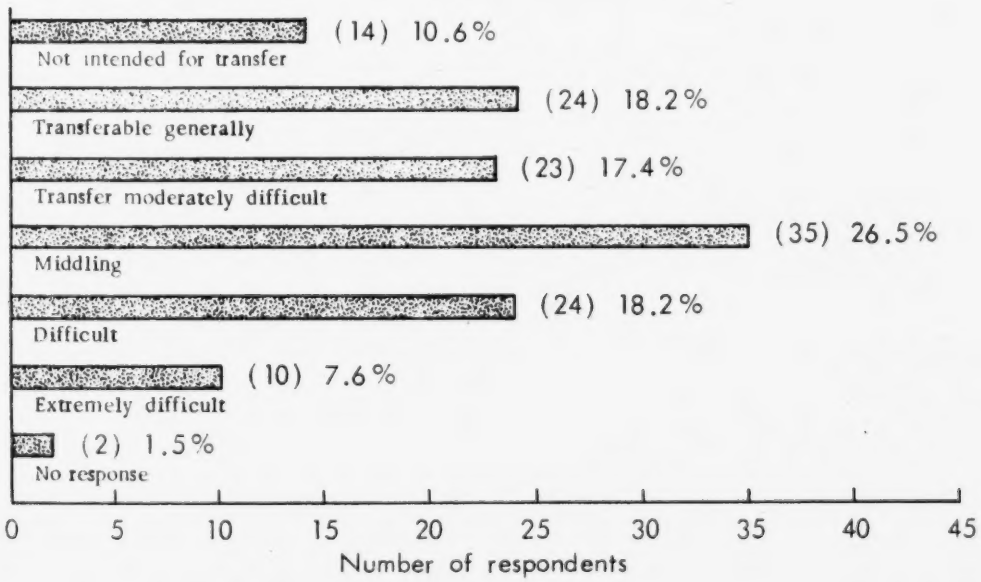

Fig. 9— Transferability of MSG: Respondents' assessments (variable TRANSU)

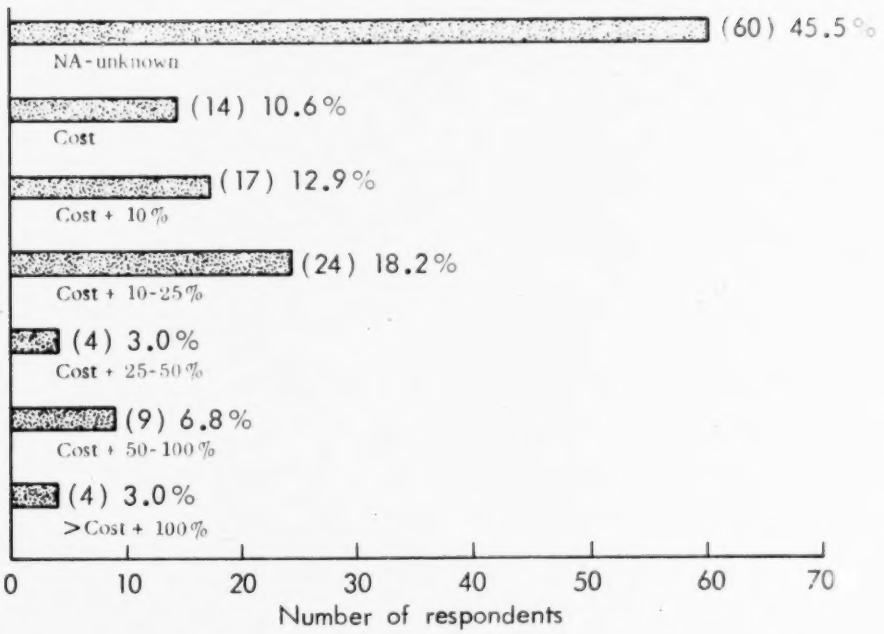

Fig. 10—Estimated transfer costs (production cost plus increment) (variable TRANSC)

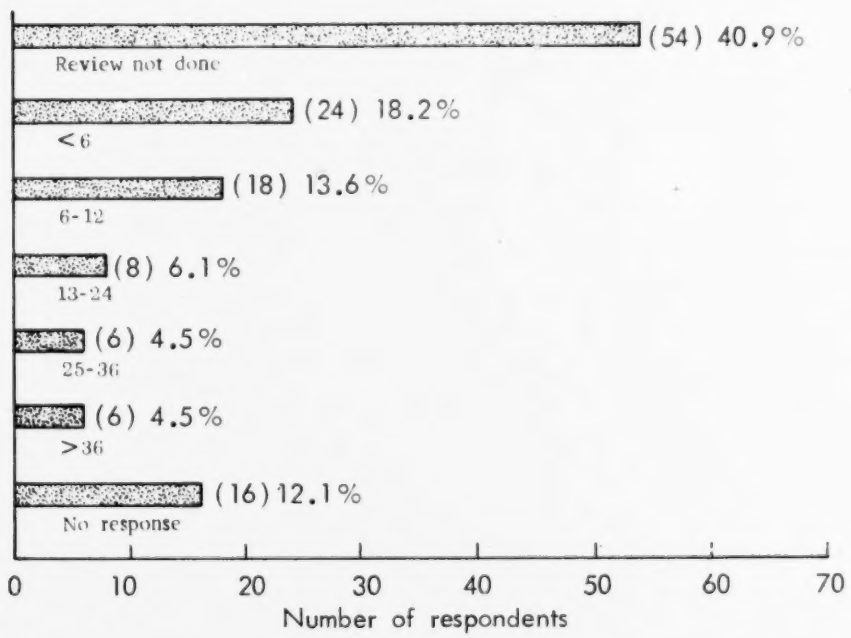

Fig. 11—Time (months) since last external professional review (variable REVDAT)

Table 1

TRENDS IN EXTERNAL PROFESSIONAL
REVIEWING OF MSGs

Incidence	1966-1967 (%)	1971-1972 (%)	Δ%
No review	22.7	50.0	+27.3
Review	59.1	38.9	-20.2
No response	18.2	11.1	-7.1

Since 1966, there has been a slight decrease in the percentage of MSGs not intended for transfer and those that are generally transferable. It appears that the extremes are moving toward a middle category of difficulty of transfer.

The lack of knowledge about transfer costs has remained steady at about 40 percent in the same period. In other words, a consistently high proportion of respondents had no idea what it would cost to replicate their MSG elsewhere.

The descriptive attributes for data sources, data-validation procedures, extent of documentation, and incidence of sensitivity testing remained stable over the period of the analysis.

Very little has ever been published in journals or books about the MSGs in this sample. However, since 1966, there has been a major percentage increase in use of the Defense Documentation Center. The primary form of documentation has been relatively stable over time--"reports only" account for 25 to 30 percent, "user manuals only," slightly less than 10 percent--but "user manual plus program decks" as a category increased from 13 to 28 percent in the period.

Relationship to Other Descriptors. Here we consider the linkage of MSG operational characteristics and the military service responsible for the MSG, and the effects of external professional reviewing on the sampled population.

No significant relationships were observed between the responsible service and any of the following operations-oriented descriptors: ease of transfer, cost of transfer, incidence of sensitivity testing, and specialized facilities.

The amount of external professional reviewing initiated by each service was significant. Based on the average for the entire sample (see Table 2), Air Force MSGs are least likely to have benefited from external reviewing. Adding the number of no-responses to the number of MSGs not reviewed reveals that over 80 percent of the sampled Air Force activity was evidently not subjected to external scrutiny. The data also indicate both the extent of the Army Models Review Committee's recent efforts and the low rate of review for "other DOD" MSGs.

Table 2

EXTERNAL PROFESSIONAL REVIEWING, BY SERVICE

Service	MSGs Not Reviewed	MSGs Reviewed	No Response	Total
USA	15	36	8	59
USAF	18	5	3	26
USN	13	21	2	36
Other DOD	7	3	1	11
Total	53	65	14	132

[X^2 $p < .003$]

When service is tabulated against the date of latest professional review, we see that 25.4 percent of the Army's entries were reviewed within the six months prior to the cutoff date of this survey--around October 1971--a significantly higher percentage than those of either the Navy or Air Force.

Of the 5 Air Force entries that were given external professional review, 3 were last looked at between one and two years ago, 1 more than three years ago, and 1 less than six months prior to the survey's cutoff date. The portion of Navy MSGs reviewed is consistent over time [X^2 $p < .05$].

The incidence of external professional review relates to other characteristics of the sample as well.

While MSGs used for analysis and diagnosis, teaching and training, or operations stood about a 50/50 chance of being reviewed, those with

research applications did not fare so well. Of the 7 research or experimentation MSGs, only 1 had had a professional review. It is curious indeed that the few explicitly scientific examples were not subjected to this rudimentary scientific control procedure.

Professional reviewing was not significantly related to transferability, transfer cost, size of the MSG, total cost to build, extent of documentation, type of data mainly used, or the incidence of sensitivity testing.

There is a significant relationship between the data sources of an MSG and its later receiving external review. If an MSG (1) underwent checking of data, (2) derived from field exercises, or (3) used data from a variety of experimental and operational sources, the chances were doubled that a professional review would be done [X^2 $p < .005$]. Likewise, if data validation procedures, as described in written commentary, were highly or moderately rigorous (and 55 or 41.6 percent were so classed), the chances of subsequent professional review were also nearly double those of MSGs having less rigorously validated data [X^2 $p < .02$]. This suggests that concern for rigorous design and production carries over into operational control procedures as well.

Unfortunately, that suggestion does not hold for sensitivity testing, which was not clearly related to professional reviewing. Curiously, sensitivity testing was strongly related to MSG size. MSGs having less than 4,000 instructions, i.e., the relatively smaller entries, were about twice as likely *not* to have had some sensitivity testing as the larger MSGs having 4,000-10,000 instructions. The largest size category (greater than 10,000 instructions) was evenly split on the question [X^2 $p < .001$]. It is not readily explicable that the procedure is carried out less frequently than expected for the smaller and probably more readily and inexpensively tested MSGs.

Documentation and the incidence of professional reviewing were related in several interesting ways.

MSGs that had been reviewed were twice as likely as those not reviewed to have their documentation located in the Defense Documentation Center, and 65 MSGs in all received some sort of external professional

review. When, for this subset, assessments of data-validation procedures are tabulated against the location of documentation, a highly significant finding emerges. Of the 34 MSGs thought to have high- and moderate-quality data validation, no less than 19 have documentation that is not generally accessible, being either proprietary/not-for-profit organization (3), proprietary/contact author (3), proprietary (classified)/contact author (10), unknown/not available (2), or out-of-print (1) [X^2 $p < .001$]. Once more we begin to take a measure of the extent of isolation of much current activity. Of the 35 MSGs whose documentation was public, located in the Defense Documentation Center, only 15 were credited with high or moderate data-validation procedures, significantly fewer than those having inaccessible or limited-access documentation. This finding is interesting enough to warrant reproducing Table 3 in full.

Table 3

CROSS-TABULATION OF DOCUMENTATION LOCATION AND QUALITY OF DATA VALIDATION FOR MSGs THAT WERE EXTERNALLY REVIEWED

(N = 65)

Documentation Location (Variable DOCLOC1)	Quality of Data Validation (Variable DATAV)						
	Unknown	High	Moderate	Weak	Not Done	No Response	Total (%)
Unknown	1	1	1	2	1	0	6 (9.2)
Out of print	0	1	0	2	0	0	3 (4.6)
Proprietary; not-for-profit organization	0	0	3	0	0	0	3 (4.6)
Proprietary; contact author	2	1	2	0	1	0	6 (9.2)
Proprietary (classified); contact author	0	4	6	1	0	0	11 (16.9)
Public; in DDC	2	3	12	8	9	1	35 (53.8)
No response	0	0	0	0	0	1	1 (1.5)
Total	5	10	24	13	11	2	65
(%)	(7.7)	(15.4)	(36.9)	(20.0)	(16.9)	(3.1)	(100.0)

NOTE: Raw chi square = 61.83, with 30 deg freedom. Significance = 0.0005.

USE

The question of use is a difficult one. There is little consensus on answers to many of the questions we raised and little evidence that they are even being discussed. Our intention in this section and the one on cost that follows is primarily to initiate discussion on these neglected matters, and secondarily to take a reading on what appears to be the present state of affairs.

Concepts and Questions

Besides asking whether an MSG's use corresponded to the major purpose for which it was constructed, we created other measures of use.

One standard is the market measure--Will the MSG sell; is its funding regularly renewed? Not exactly an ideal criterion, it provides a crude pragmatic indication of the client's satisfaction and willingness to buy and use more of the same.

Two operational questions approached the matter slightly differently. The question, "How many briefings were given, based on the results produced by the MSG?" may give one an idea of how much stock a user places in a particular MSG. If no briefings resulted, that tells something about how key participants assess a given enterprise. The corollary question, "How many times is the MSG referred to in making specific operational decisions?" further refines and clarifies this measure. To push it to something like an ideal criterion, one should interview all relevant participants to determine precisely how an MSG related to a specific decision, who advocated it, who voiced reservations, and what official rationalizations derived from it. We had neither the time nor other resources to do that. The questions of who initiated the MSG and for what purpose come to bear at this point to dramatize an MSG's use. Straightforward questions such as, "Is the MSG active or not?" and "How often is it operated?" provide further important information.

Operations and use overlap when considering what kinds of documentation are located where, how easy it is to transfer use from one site to another, and the rate at which and reasons why an MSG becomes obsolescent.

Results

Description. Primary categories of actual use are shown in Fig. 12. The emphasis among initiators on the use of MSGs for analysis and diagnosis is reflected nearly exactly in the way respondents indicated MSGs are being used. The other possible primary utilization categories taken together account for less than 22.0 percent of the sample. Respondents indicated that 42 or 31.8 percent of the MSGs have secondary uses and that 13 or 9.8 percent have tertiary uses. Of those with secondary uses, 30 are used for operations, 5 for analysis and diagnosis, 4 for research and theory development, and 3 for experimentation.

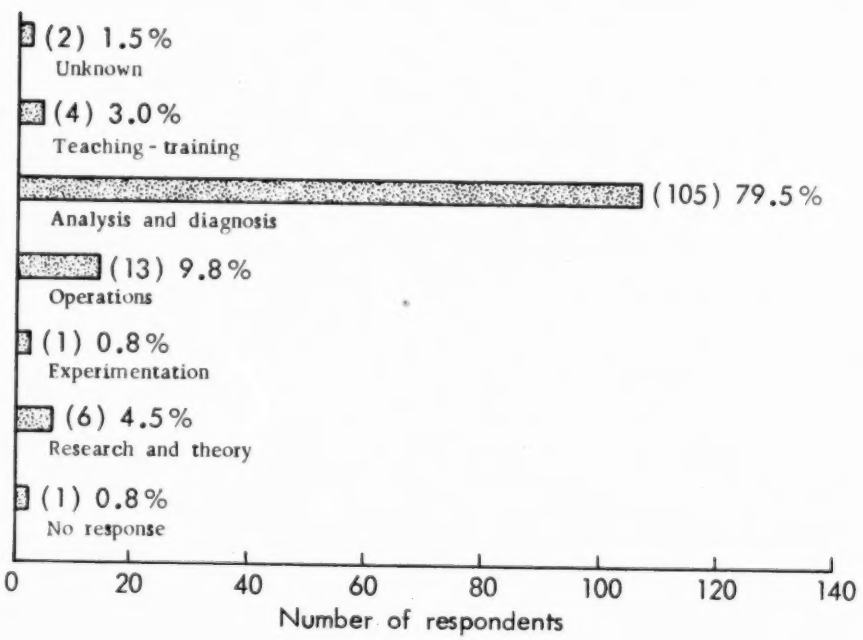

Fig. 12—Respondents' primary classification of MSG use (variable USE 1)

About 80 percent of the respondents were highly or absolutely certain about how their MSGs are being used.

Queries about genealogy (discussed on p. 22, above) revealed that nearly three-fourths of the sample have a direct antecedent and about one-third have already spawned offspring. The crude market measure

of utilization tells us that business is good and clients are sufficiently contented to keep funds flowing.

Several questions were asked about briefings. For some models the number of briefings may not be a good measure, but for games and simulations it usually is. Frequently a briefing may be no more than a superficial performance, but at least it indicates that someone considered the work interesting enough to produce. To the simplest question about the total number of briefings based on the particular MSG (see Fig. 13), 11.4 percent of the respondents replied "none," and 42.4 percent simply did not know.

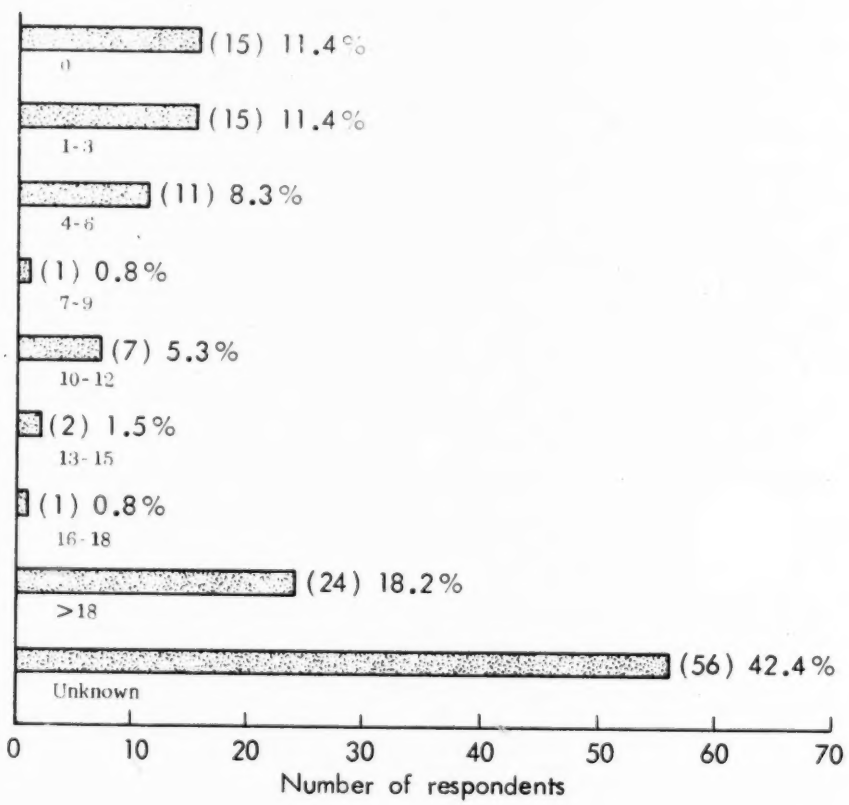

Fig. 13—Total number of briefings based on MSGs (variable BRIEF)

Respondents were asked for written commentary on the level (organization and personnel) and purpose (decisions dependent on MSG) of

the briefings that were given. The 61 MSGs for which answers were given were commonly briefed to the project staff, to an immediate superior in the organizational hierarchy, or occasionally to flag-level officers and their civilian counterparts at the top command levels of the services. The purposes of those briefings were not reported consistently enough to allow simple coding and categorization, so verbal summary abstracts were recorded for each MSG by name. Examples of common replies include the following: used for input to other studies (SEANITEOPS), strategic posture choices (NEWCON), information on F-15 performance (TAC AVENGER), no decisions based on model (AREA DOMINATION II), and selection of weapons for DLGN-25 (AAWSEM).

Generally, briefings appear to have been generated for the benefit of one or a few colonels or generals (or their naval and civilian counterparts) who occupy studies and analysis roles in their respective services. What further use these audiences made of the briefing information is not determinable from the questionnaire answers and would require extensive personal interviewing to resolve.

Let us reiterate that nearly half the MSGs surveyed had not produced a single briefing.

The question of who initiates the development of an MSG was discussed earlier (p. 17). As revealed in Fig. 3, analytic and diagnostic purposes predominate. Comparing those data with responses in Fig. 12 suggests that to a marked degree initiators are getting what they requested.

The frequency of MSG operation suggests another dimension of use. A distinctly bimodal distribution is evident in the data shown in Fig. 14 on the average annual frequency of MSG use.

Limitations on the availability of documentation and problems of transferability, touched on when describing operations, do little to promote widespread use. We asked about the availability and location of documentation. Public availability was concentrated in the Defense Documentation Center; no MSGs had documentation in the Library of Congress; and only one was listed as having been written up in journals or books. Multiple sources of documentation were listed, but only three respondents checked two sources, and only two checked three separate sources.

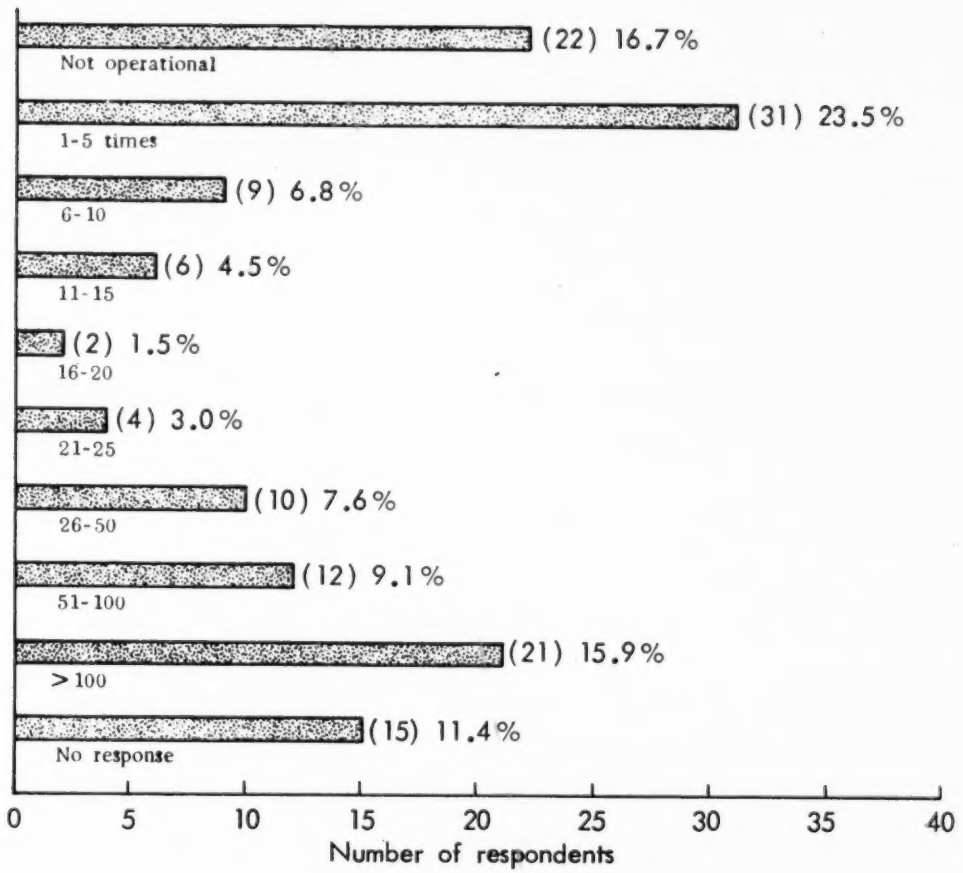

Fig. 14—Average frequency of MSG operation per year (variable OPFRQ1)

The cost of keeping an MSG up-to-date and, to a lesser extent, the average cost of running an MSG bear on its utilization. To get at annual update costs, we asked for information on total dollars, professional man-years, and programmer man-years expended over and above "normal" operating costs. For the 71 MSGs for which replies were given, cost data are summarized in Fig. 15. It is clear that updating is not a trivial matter; likewise, the sampled MSGs are generally expensive to run. Figures on the cost of a single MSG run, assuming only minor or no variations in input values, are shown in Fig. 16.

Trends. The availability and location of documentation have changed somewhat for MSGs that have become operational since 1966. On a percentage basis, more documentation is being located in the Defense

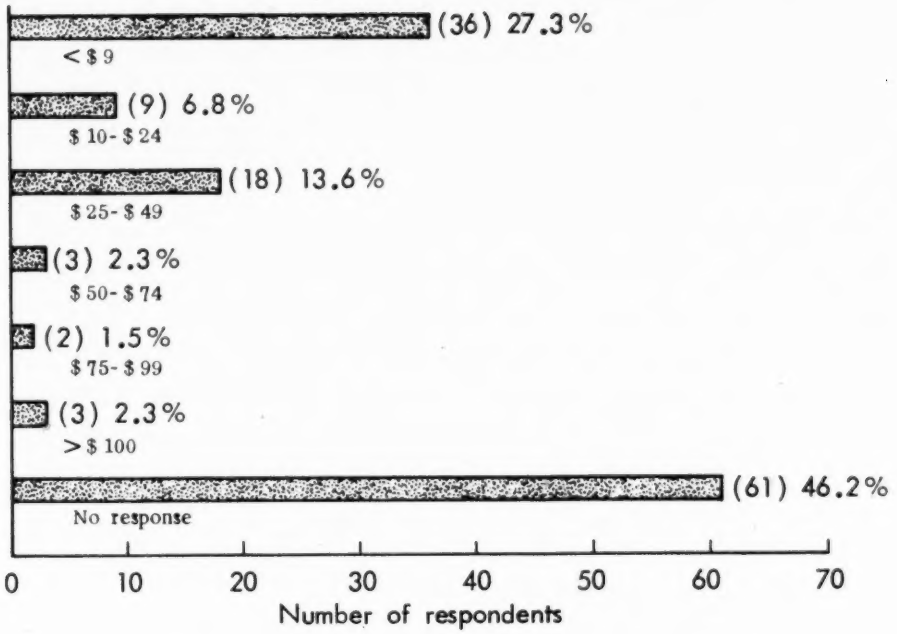

Fig. 15—Total annual MSG update costs (in $ thousands) (variable CSTUP)

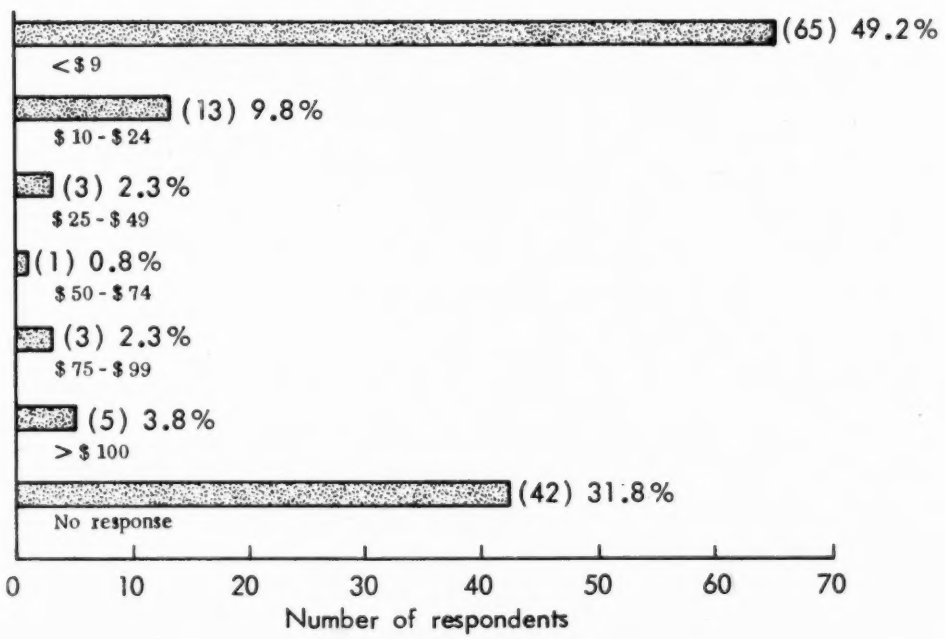

Fig. 16—Cost of a single run of MSG (in $ thousands) (variable CSTRUN)

Documentation Center, but more also is proprietary, classified, and available only from the author. Fewer MSGs have documentation that is proprietary, available from a not-for-profit firm and proprietary, or unclassified and available only from the author.

Average annual update costs are changing in significant ways. Fewer MSGs, on a percentage basis, are updated for less than $10,000 now than in 1966 (16.7 percent now versus 36.4 percent then), but no MSGs currently fall in the $50,000-$100,000 range. What has happened is that MSGs in the two intermediate ranges have increased, as shown in Table 4. Other trends in use are not so clearly discernible.

Table 4

TRENDS IN THE COST OF ANNUAL UPDATE

Cost ($ thousands)	1966-1967 (%)	1971-1972 (%)	Δ%
$ < 10	36.4	16.7	-19.7
$10-$24	9.1	11.1	+2.0
$25-$49	9.1	22.2	+13.1

Relationship to Other Descriptors. Respondents were highly or absolutely certain about the actual use of an MSG in nearly 80 percent of the cases. No significant association was noted between category of use and level of confidence.

The correspondence between the initiator's intended purpose and the actual use to which the MSG was put was strikingly consistent. If someone wanted an MSG for analysis and diagnosis, he got it 97/108 or 89.8 percent of the time. The other 11 MSGs ended up being used primarily for teaching and training (3), operations (3), experimentation (1), research and theory development (1), or, the respondent did not know or did not reply (3) [X^2 $p < .001$]. Those deflections of intent are minor indeed.

When the respondent's role was tabulated against his assessment of the quality of his MSG's documentation, we found that funders and sponsors were the most likely to claim excellent documentation rather than

any other possible quality category, 7/19 or 36.8 percent. Users indicated that documentation was very good more frequently than other categories, 16/42 or 38.1 percent. Designer/builders opted for average, 14/41 or 34.1 percent, and very good, 12/41 or 29.3 percent, in nearly equal measure. However, caretakers indicated predominantly that documentation was either average, 8/18 or 44.4 percent, or poor, 4/18 or 22.2 percent [X^2 $p < .001$]. While several interpretations are plausible, it seems that those farthest removed from actual MSG use (funder-sponsor) are the most glowing in their assessments of documentation quality.

On the average, about one-third of the respondents did not know whether their MSG had been briefed or not. When those for which no briefings had been given were totaled with this unknown category and then tabulated against responsible military service, the information in Table 5 was produced. The relationship is not statistically significant, but it suggests that the MSGs in this sample are either not being used or, more likely, that people responsible for their use are not keeping track of how often they are used.

Table 5

BRIEFINGS BASED ON MSGs, BY SERVICE

Service	MSGs Not Briefed or Unknown	MSGs Briefed	Total
USA	34	25	59
USAF	12	14	26
USN	14	22	36
Other DOD	11	0	11
Total	71	61	132

Annual frequency of operation and update costs are related to the individual services in significant and interesting ways. The bimodal nature of annual use holds for all services. A given MSG will, about 25 percent of the time, be operated one to five times a year, if at all; at the other extreme, it has about a 15 percent chance of being

operated in excess of one hundred times a year [X^2 $p < .05$]. Annual updating costs are approximately the same for all services. For their part of the total sample, 30.5 percent of the Army's MSGs cost less than $10,000, compared with 34.6 percent of the Air Force's and 22.2 percent of the Navy's. The next most frequent cost range is $25,000-$49,000, which accounts for about 12 percent of each service's MSGs [X^2 $p < .005$].

COSTS

A somewhat cynical, but wise, gamester of our acquaintance claims that gaming activities cost whatever the bookkeepers want to make them cost. There are many lengthy, complicated reasons validating that remark, but suffice it to say that costs are deceptively hard to determine.

As the work involves many invisible costs, overhead costs, jointly shared facilities, and jointly used products, formulating a meaningful costing procedure poses deep scientific problems that are far from being resolved. The respondents to our survey found it difficult even to give a simple cost description.

Concepts and Questions

The questionnaire contained a large number of cost questions. Besides attempting to characterize the nature of costs using several plausible dimensions and categories, we were interested in determining the amount of current attention to costs and the general level of knowledge in the profession about costs.

Answers on all three topics--nature, attention, and knowledge--were disappointing. More than a third of the respondents simply did not answer cost questions, and of those who did, the variability of replies was large and the level of confidence was low. If these qualified professionals, being asked cost questions by the U.S. General Accounting Office on behalf of the House Appropriations Committee, could not come up with some sort of figures, it is difficult to see who can, unless cost records are kept with the work.

Results

Description. Though nearly three-fourths of the MSG sample had at least one direct antecedent, 62.1 percent of the respondents either did not know or failed to respond to a question about the costs for these MSG families. Moreover, of those that answered, uncertainty about the answers was high; over half had low confidence in their responses. This suggests that cost considerations are discontinuous, i.e., costs are not accumulated, even though changes in the MSG may be marginal from one version to the next. Costs easily become separated from substance.

Direct funds, money formally assigned for construction purposes, were used by 61 or 46.2 percent of the sample. How these funds were distributed is shown in Fig. 17. Confidence levels were low in nearly half the cases.

Total or gross costs--direct, indirect, imputed, and unimputed--are depicted in Fig. 18. The confidence level for this roughest approximation of costs was slightly better than for the other more detailed cost categories but considerably worse than for other kinds of variables. For instance, on the classification of MSG purpose, 80 percent were either highly or absolutely certain. On total costs, only 20.4 percent were as confident.

Other cost categories have been discussed in earlier sections. For example, man-years expended to construct an MSG and sources of funds were mentioned under "Production"; transfer costs and special facilities under "Operations"; and update and single-run costs under "Use." What those sections reveal only confirms our impression that (1) generally accepted, simple accounting definitions do not exist, (2) insufficient attention is paid to costs to manage these MSGs effectively, and (3) few people know how much money was invested in their MSG, how much is being spent to operate and maintain it, and what monetary benefits are accruing. It appears that elementary questions such as "What was bought for how much?" seldom get asked.

Trends. Trends in three categories are worth considering: total, transfer, and update costs. The incidence of "unknown" and no responses for total cost information on all MSGs is steady at around 25 percent

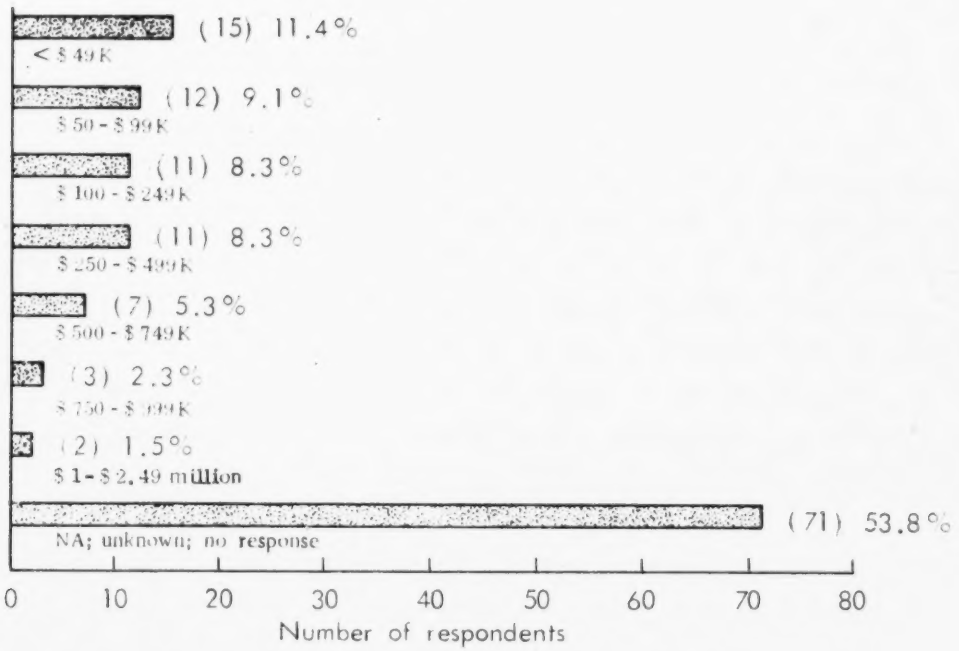

Fig. 17—Direct funds for MSG construction (variable FUNDIR)

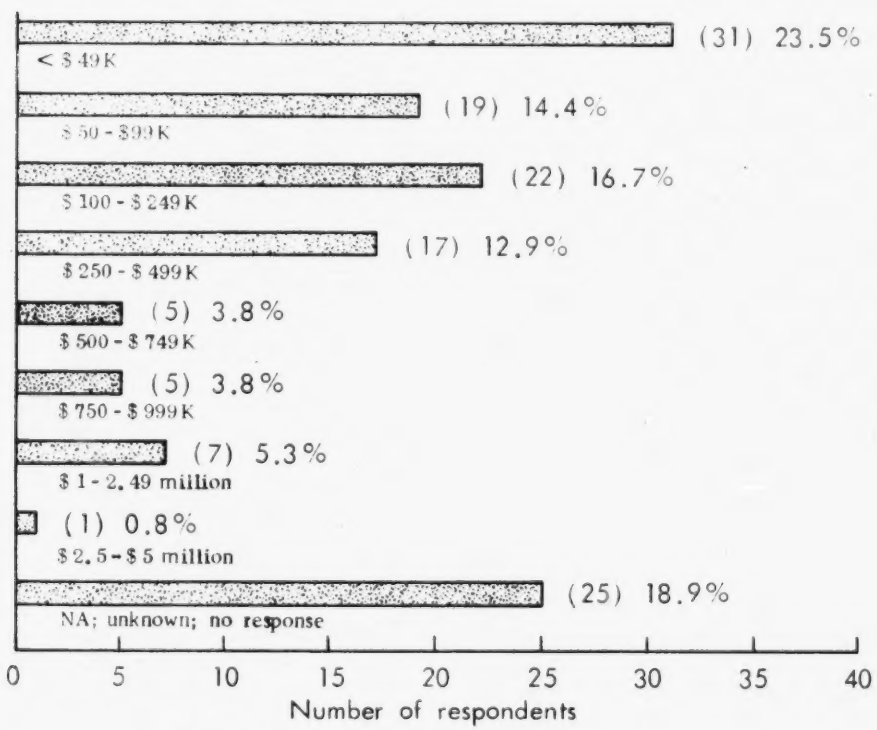

Fig. 18—Total MSG costs: Direct, indirect, imputed, unimputed (variable TOTCST)

for the years after 1964. In other words, a fourth of the respondents did not even bother to guess. The proportion of MSGs in each of the cost ranges has remained relatively stable over time. Unknowns and no-responses regarding transfer costs increased over those regarding total costs to 45 percent for MSGs initiated after 1966. The amount of no-responses and unknowns regarding update costs is about steady at 40 percent.

Relationship to Other Descriptors. Because so little information was given, fewer statistical tables were generated for cost than for other descriptive variables. No significant associations existed between total costs and the incidence of professional reviewing, data sources, or general classification (model, simulation, man-machine game, etc.).

When military service was tabulated against direct costs, the data in Table 6 were generated. When the process was repeated for total costs (Table 7), the pattern shifted somewhat. Not only were there more responses, but the distribution changed. The information in this table is not statistically significant [X^2 $p < .09$, n.s.] but nevertheless worth presenting.

OPINIONS OF RESPONDENTS

We asked the respondents their professional opinions about a number of issues, including the potential usefulness of clearinghouses, regional centers, and external professional review boards. We built redundancy into the questionnaire in this regard, asking similar questions in different portions of the questionnaire in slightly different ways, to provide consistency checks.

Description of Results

On the question of establishing a clearinghouse to coordinate information about all MSG activities within the Department of Defense, respondents were generally quite favorably disposed, as shown in Fig. 19. More than half thought it would be useful or highly useful.

Twice we raised the issue of standardization. The first time, it was in the question, "What is your belief in the advisability of increasing DOD gaming and simulation activity for standardization?" Respondents were asked to check one category on a five-point scale from

Table 6

CROSS-TABULATION OF MILITARY SERVICE AND DIRECT COSTS

Service	Direct Costs (Variable CSTDIR)								
	< $49K	$50-$99K	$100-$249K	$250-$499K	$500-$749K	$750-$999K	$1-$2.49 million	Unknown NR	Total (%)
USA	12	12	4	7	5	0	1	18	59 (44.7)
USAF	5	0	2	0	0	0	1	18	26 (19.7)
USN	8	10	9	1	2	2	1	3	36 (27.3)
Other DOD	1	1	3	1	1	1	0	3	11 (8.3)
Total	26	23	18	9	8	3	3	42	132
(%)	(19.7)	(17.4)	(13.6)	(6.8)	(6.1)	(2.3)	(2.3)	(31.8)	(100.0)

NOTE: Raw chi square = 47.42, with 21 deg freedom. Significance = 0.0008.

Table 7

CROSS-TABULATION OF MILITARY SERVICE AND TOTAL COSTS

Service	Total Costs (Variable TOTCST)									
	< $49K	$50-$99K	$100-$249K	$250-$499K	$500-$749K	$750-$999K	$1-$2.49 million	$2.5-$5 million	Unknown NR	Total (%)
USA	15	6	7	7	4	1	4	1	14	59 (44.7)
USAF	10	6	2	1	0	0	1	0	6	26 (19.7)
USN	4	6	10	8	1	2	2	0	3	36 (27.3)
Other DOD	2	1	3	1	0	2	0	0	2	11 (8.3)
Total	31	19	22	17	5	5	7	1	25	132
(%)	(23.5)	(14.4)	(16.7)	(12.9)	(3.8)	(3.8)	(5.3)	(0.8)	(18.9)	(100.0)

NOTE: Raw chi square = 33.36, with 24 deg freedom. Significance = 0.0965.

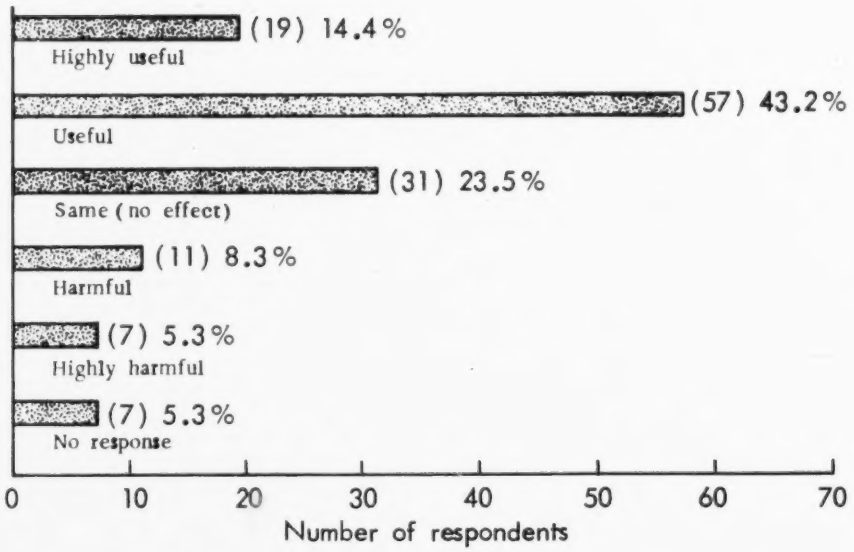

Fig. 19—Respondents' opinions on MSG clearinghouses (variable CLEAR)

highly useful to highly harmful. The second time, near the end of the questionnaire, the question was phrased, "Is it premature to try to form a professional standards committee for models, games, and simulations? Is it needed? Would it probably do good or harm?" This time we asked for written commentary, which was later coded as highly useful, useful, same as present, harmful, highly harmful, or no response. The comments gave insight into why there was such pronounced opposition to standardization, as evidenced in Fig. 20.

We also asked for opinions on the initiation of regional centers to coordinate production, operation, and use. Some 60 percent thought such centers would be harmful or highly harmful. Another question asked respondents whether the creation of external reviewing boards would be an improvement. Some 57 percent opposed the idea, terming it harmful or highly harmful and impossible to staff adequately.

On each question we asked respondents to amplify their categorical responses with written commentary. The prevailing attitude of those opposed to clearinghouses was that it would add an unnecessary layer to the existing bureaucracy. Roughly, the sentiment was, "In theory it sounds fine, but in practice it just won't fly." We were struck by the extent of concern voiced by some of the more widely known and professional

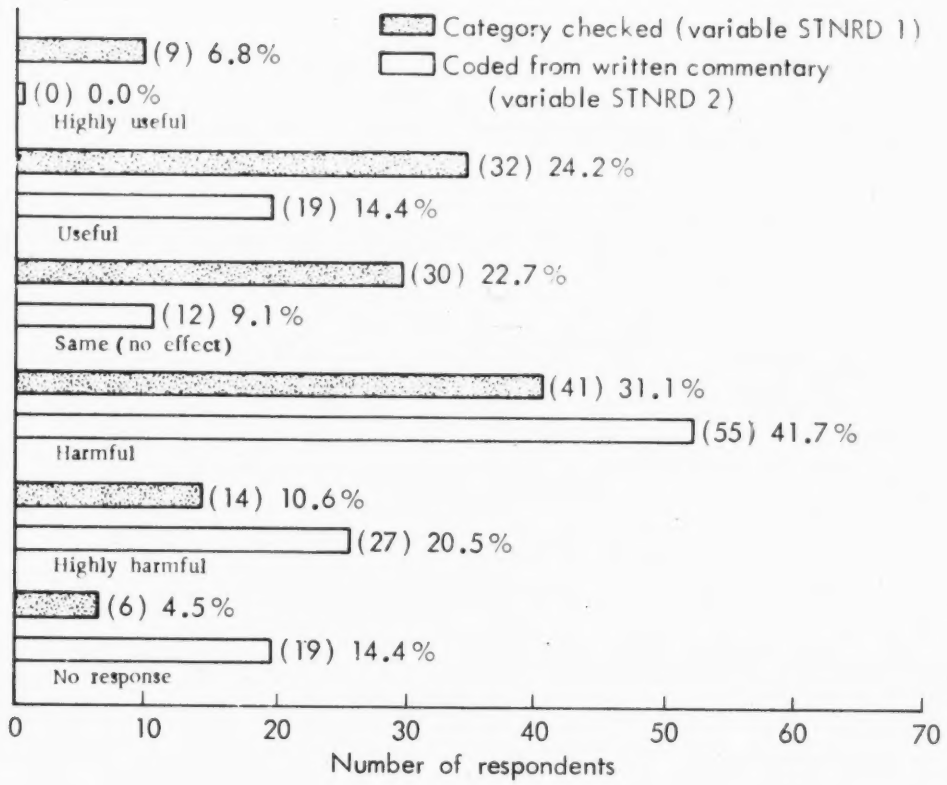

Fig. 20—Respondents' opinions on standardization

of the respondents about standardization of many kinds--of languages, data formats, or documentation. They considered attempts to standardize premature and feared they would stifle creativity. Incidentally, the few respondents who favored standardization were mainly users with little or only recent experience. The relatively negative reaction toward creating regional centers was also based on the concern that such centers would not only add bureaucratic problems but would also separate the work from those who know, need, and use it. Those who could see some merit in regional centers argued that they would save money on personnel and computer resources. Any benefit from coordinating data processing and computer software systems was mentioned only occasionally.

One of the most interesting sets of replies dealt with external reviewing procedures and boards. Some 17.4 percent indicated that they would be highly harmful; 39.4 percent suggested that they would be

harmful; and only one respondent thought the idea would be highly useful. The argument against the review board was that it would be impossible to assemble a high-quality panel to review specific models in sufficient depth to justify the time and effort. Many respondents felt, some in no uncertain terms, that they were perfectly capable of providing all the review needed. Based on this survey's results and informal, supplementary interviews, we doubt that they are right.

Relationship to Other Descriptors

We tabulated all opinion questions against the respondent's own role, to determine whether one's location in the decision process had any noticeable effects, and against the service responsible for each MSG, to judge whether organizations had systematic preferences.

While no significant relationships existed between respondent role and opinions about clearinghouses, external review, or technical coordination, other matters were significant.

For example, the correlation of respondent's role with opinions about standardization (Table 8) shows that funders/sponsors most favor the creation of standards, closely followed by caretakers; designers and builders are the least favorable; and users are somewhere in between. The correlation of respondent's role with opinions about creating regional centers (Table 9) reveals that funders/sponsors are again most in favor, although less so than for standards. Again, designers and builders are least in favor, but they too are less strongly committed than on the standardization issue.

Tabulations of service opinions on the creation of clearinghouses are shown in Table 10; on standardization, Table 11; and on technical coordination, Table 12.

EVALUATION OF THE QUESTIONNAIRE BY RESPONDENTS AND RESEARCHERS

We solicited respondents' opinions about the questionnaire, and in turn we rated the general overall quality of each respondent's replies. Because the questionnaire is formidable, we checked to see what, if any, systematic relationships existed between the time required to fill it out, the respondent's appraisal of it, and our

Table 8

CROSS-TABULATION OF RESPONDENT'S ROLE AND OPINIONS ON STANDARDIZATION

Role (Variable RESROL1)	Opinion (Variable STNRD1)						
	Highly Useful	Useful	Same	Harmful	Highly Harmful	NR	Total (%)
Funder-Sponsor	2	10	3	3	1	0	19 (14.4)
User	2	10	10	17	2	1	42 (31.8)
Designer-Builder	2	4	14	14	5	2	41 (31.1)
Caretaker	3	7	2	5	1	0	18 (13.6)
Control	0	0	0	1	1	0	2 (1.5)
Other	0	1	1	1	4	3	10 (7.6)
Total	9	32	30	41	14	6	132
(%)	(6.8)	(24.2)	(22.7)	(31.1)	(10.6)	(4.5)	(100.0)

NOTE: Raw chi square = 56.45, with 25 deg freedom. Significance = 0.0003.

Table 9

CROSS-TABULATION OF RESPONDENT'S ROLE AND OPINIONS ON REGIONAL CENTERS

Role (Variable RESROL1)	Opinion (Variable REGCEN)						
	Highly Useful	Useful	Same	Harmful	Highly Harmful	NR	Total (%)
Funder-Sponsor	0	5	1	8	4	1	19 (14.4)
User	1	4	5	21	5	6	42 (31.8)
Designer-Builder	0	6	3	18	9	5	41 (31.1)
Caretaker	0	2	0	12	0	4	18 (13.6)
Control	0	0	1	1	0	0	2 (1.5)
Other	0	0	1	1	1	7	10 (7.6)
Total	1	17	11	61	19	23	132
(%)	(0.8)	(12.9)	(8.3)	(46.2)	(14.4)	(17.4)	(100.0)

NOTE: Raw chi square = 42.53, with 25 deg freedom. Significance = 0.0157.

Table 10

CROSS-TABULATION OF MILITARY SERVICE AND OPINIONS ON CLEARINGHOUSES

Service (Variable SERVIC)	Opinion (Variable CLEAR)						
	Highly Useful	Useful	Same	Harmful	Highly Harmful	NR	Total (%)
USA	11	25	14	6	1	2	59 (44.7)
USAF	3	8	8	1	1	5	26 (19.7)
USN	3	23	2	4	4	0	36 (27.3)
Other DOD	2	1	7	0	1	0	11 (8.3)
Total	19	57	31	11	7	7	132
(%)	(14.4)	(43.2)	(23.5)	(8.3)	(5.3)	(5.3)	(100.0)

NOTE: Raw chi square = 41.12, with 15 deg freedom.
Significance = 0.0003.

Table 11

CROSS-TABULATION OF MILITARY SERVICE AND OPINIONS ON STANDARDIZATION

Service (Variable SERVIC)	Opinion (Variable STNRD1)						
	Highly Useful	Useful	Same	Harmful	Highly Harmful	NR	Total (%)
USA	4	19	10	20	5	1	59 (44.7)
USAF	3	3	9	4	2	5	26 (19.7)
USN	0	9	7	13	7	0	36 (27.3)
Other DOD	2	1	4	4	0	0	11 (8.3)
Total	9	32	30	41	14	6	132
(%)	(6.8)	(24.2)	(22.7)	(31.1)	(10.6)	(4.5)	(100.0)

NOTE: Raw chi square = 35.67, with 15 deg freedom.
Significance = 0.0020.

Table 12

CROSS-TABULATION OF MILITARY SERVICE AND OPINIONS ON TECHNICAL COORDINATION

Service (Variable SERVIC)	Opinion (Variable TECH)						
	Highly Undesirable	Undesirable	Indifferent	Desirable	Highly Desirable	NR	Total (%)
USA	9	8	7	15	19	1	59 (44.7)
USAF	2	3	9	2	2	8	26 (19.7)
USN	5	7	6	11	6	1	36 (27.3)
Other DOD	1	0	6	2	2	0	11 (8.3)
Total	17	18	28	30	29	10	132
(%)	(12.9)	(13.6)	(21.2)	(22.7)	(22.0)	(7.6)	(100.0)

NOTE: Raw chi square = 46.85, with 15 deg freedom. Significance = 0.0001.

evaluation of the quality of the replies. We also checked the two evaluation descriptors against the respondent's role and the military service responsible for the MSG.

We assessed the quality of the responses before we knew how the respondent had evaluated the questionnaire. As shown in Table 13, overall distributions were quite similar. Though the relationship is not statistically significant, users and funders/sponsors were more favorably disposed to the questionnaire than were others; designers and builders were less pleased. We expected that to some extent, because the questionnaire frankly favors issues of import to the user that many builders apparently ignore or hold in less esteem.

Our opinion of the quality of respondents' replies indicates that users generally provided us with better overall responses than other groups, and caretakers provided the poorest.

Service-specific opinions were not statistically significant on questions of regional centers, external review, or quality of the questionnaire. Our own evaluation of responses by service indicates that on the average the Army did better than the others: 15/59 or 24.4 percent were good or excellent. Perhaps that is because of the demands placed on the Army segment of the profession by the ad hoc Models Review

Table 13

CROSS-TABULATION OF RESEARCHERS' EVALUATION OF RESPONSES AND RESPONDENTS' EVALUATION OF THE QUESTIONNAIRE

Researchers' Evaluation (Variable IQC)	Respondents' Evaluation (Variable QUEVAL)						
	Excellent	Good	Modal	Poor	Bad	No Response	Total (%)
Excellent	0	2	1	0	0	0	3 (2.3)
Good	2	7	12	3	1	1	26 (19.7)
Modal	1	11	10	10	6	5	43 (32.7)
Poor	0	5	5	12	8	10	40 (30.4)
Bad	0	2	6	7	2	3	20 (15.2)
Total	3	27	34	32	17	19	132
(%)	(2.3)	(20.7)	(25.8)	(24.3)	(12.9)	(14.4)	(100.0)

NOTE: Raw chi square = 53.41, with 20 deg freedom. Significance = 0.0001.

Committee. On the other hand, other DOD and Air Force replies were poor or bad, 8/11 or 72.8 percent and 17/26 or 64.3 percent, respectively. Navy responses were predominantly modal in quality, 17/36 or 47.2 percent.

Time taken to complete the questionnaire was significantly related to both respondent and researcher evaluations (see Table 14). Of the 30 respondents who thought the questionnaire was excellent or good, 26 or 86.6 percent required 15 hours or less to complete it. However, when researchers' evaluation is tabulated against completion time (Table 15), the excellent and good responses, while concentrated under 15 hours, are spread somewhat more along the time dimension. We conjecture that if a respondent intimately knew his MSG, he could respond thoroughly and competently in under 15 hours; if not so knowledgeable but sympathetic to the purposes of the investigation, he could produce high-quality responses at some additional cost in time. It is also interesting to see that as regards the three respondents who took over 50 hours to complete the questionnaire, mutual enmity prevails: they rated the questionnaire low, and, despite their protracted completion time, we found their answers poor.

Table 14

CROSS-TABULATION OF RESPONDENTS' COMPLETION TIME
AND EVALUATION OF THE QUESTIONNAIRE

Time (Variable QT) (hr)	Evaluation (Variable QUEVAL)						
	Excellent	Good	Modal	Poor	Bad	No Response	Total (%)
0-5	2	11	9	21	8	10	61 (46.1)
6-10	0	6	10	8	4	3	31 (23.5)
11-15	0	7	6	0	0	1	14 (10.6)
16-20	1	2	3	0	1	0	7 (5.3)
21-25	0	0	3	0	0	1	4 (3.0)
26-30	0	0	1	1	0	1	3 (2.3)
31-35	0	0	0	1	2	0	3 (2.3)
36-40	0	0	1	1	0	0	2 (1.6)
41-45	0	0	0	0	0	0	0 (0.0)
46-50	0	1	0	0	0	0	1 (0.8)
≥ 51	0	0	0	0	2	1	3 (2.3)
NR	0	0	1	0	0	2	3 (2.3)
Total	3	27	34	32	17	19	132
(%)	(2.3)	(20.7)	(25.8)	(24.3)	(12.9)	(14.4)	(100.0)

NOTE: Raw chi square = 82.64, with 55 deg freedom. Significance = 0.0125.

Table 15

CROSS-TABULATION OF QUESTIONNAIRE COMPLETION TIME AND RESEARCHERS' EVALUATION OF RESPONSES

Time (Variable QT) (hr)	Evaluation (Variable IQC)					
	Excellent	Good	Modal	Poor	Bad	Total (%)
0-5	0	7	20	22	12	61 (46.1)
6-10	2	5	15	6	3	31 (23.5)
11-15	1	7	3	2	1	14 (10.6)
16-20	0	0	4	1	2	7 (5.3)
21-25	0	3	0	1	0	4 (3.0)
26-30	0	1	0	2	0	3 (2.3)
31-35	0	1	0	2	0	3 (2.3)
36-40	0	0	1	1	0	2 (1.6)
41-45	0	0	0	0	0	0 (0.0)
46-50	0	1	0	0	0	1 (0.8)
≥ 51	0	0	0	2	1	3 (2.3)
NR	0	1	0	1	1	3 (2.3)
Total	3	26	43	40	20	132
(%)	(2.3)	(19.7)	(32.7)	(30.4)	(15.2)	(100.0)

NOTE: Raw chi square = 61.03, with 44 deg freedom.
Significance = 0.0512.

III. CONCLUSIONS

The general discipline known as gaming/simulation is highly diverse. It encompasses at least four different subjects that have different criteria for validation and different measures for cost and effectiveness. That makes it a difficult entity to grasp analytically. Nevertheless, in the following pages, we venture our opinions on the significance of the results of our survey. They are summarized under the same substantive headings as were the results analyzed in Sec. II.

MSG PURPOSES

Weapon system evaluations, mostly built by the individual military services for their own exclusive purposes and use, predominate, both in absolute level of activity and in total expenditures. Ironically, expenditures and public knowledge about gaming and simulation are inversely related. Free-form gaming has received great and continuing notoriety, but its expenditures are trifling compared with expenditures on all-machine, technical evaluations. Many models, simulations, and games are literally unknown outside a small user-producer coterie.

The degree of knowledge that anyone of even this in-group may have about a particular MSG is evidently limited. Many poor, incomplete, and low-confidence replies were obtained from responsible and knowledgeable professionals. That several respondents took upwards of 70 hours to complete the questionnaire reinforces this view.

Also worrisome is the amount of what is essentially research money that is being spent in the absence of rigorous and accepted research standards. As a result, basic knowledge about both substantive and procedural matters is neglected. Very little is being spent on validation efforts and on basic research about MSG methods, data, and uses, without which the credence of gaming and simulation suffers.

In our opinion, the copious in-house production of technical-evaluation models is being pursued without sufficient attention to quality and scientific rigor:

- o In many cases, in-house work has ignored scientific standards of data collection, management, and validation.
- o Documentation of in-house work is often very poor; this failing is frequently rationalized on the grounds that the work is not meant to get outside the builder's shop.
- o About half the sampled MSGs were not externally reviewed; most respondents reject the need for such reviews on bureaucratic rather than scientific grounds.

PRODUCTION

The evident preference for large, all-machine models and simulations is questionable on several grounds. Large-scale, finely detailed MSGs that try to deal with problems having significant uncertainties may only serve to generate errors, not clarifying anything.* Given what appear to be weak-to-poor data, extremely fine temporal and spatial levels of model resolution, and low levels of demonstrated concern for supporting research, the MSGs produced may have doubtful reliability.

Large models are usually complicated, expensive to build and use, take extended periods to operate and interpret, and are the least scientifically defensible. They quickly begin to suffer from the disorganization created by changes in purpose and personnel, bad documentation, gaps in logic, and problems of data-base preparation, maintenance, and validation.

If large models must be produced, the key to control seems to be in continuity of personnel. Changes of personnel have significant effects. Usage decreases because no one knows what a model is supposed to do, how it does it, or why. Where sunk costs are great, there is a tendency to use a large and expensive model anyway, even though none of its caretakers can determine its validity for new applications. Documentation should ameliorate this problem, but it seldom does.

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*For a technical discussion see John W. Tukey, "The Propagation of Errors, Fluctuations and Tolerances: Basic Generalized Formulas," Report No. 10, Department of Mathematics, Princeton University; for a more practical view, see William Alonso, "The Quality of Data and the Choice and Design of Predictive Models," in G. C. Hemmens, ed., *Urban Development Models*, Special Report No. 197, Highway Research Board, Washington, D.C., 1968, pp. 178-192.

OPERATIONS

We believe that documentation is considerably worse than the questionnaire replies indicate. Documentation standards, requiring that documentation meet certain specific criteria, cost little extra for their large contribution to better management control. The need is particularly great in the case of very large simulations. When generations of programmers perpetuate inconsistencies and errors in sloppily updated documentation, all can be lost.

Many capabilities built into these devices have not been subjected to validation. Not only is their empirical basis dubious or admitted to be lacking, but few efforts are being made to collect missing or questionable input data or to execute sensitivity analyses according to an appropriate experimental design. The lack of sensitivity analysis is related to deficiencies in estimating the validity of input parameters. Neither of these matters seems to be taken seriously. There is a less than 50/50 chance that a sensitivity test will be done, and when it is done, there is frequently no record of the outcome.

Most of the surveyed MSGs have not been subjected to any external review, with the result that many contain implicit and intangible inputs whose existence and rationale have not been documented in any way. The so-called "institutional memory" in the general system is not very well developed. Even about MSGs of fairly recent vintage, respondents seem unable to answer technical and cost questions very well or with much confidence.

One colleague has suggested only half facetiously that validation is a happy customer.* If so, is ultimate validation a follow-on contract? A comprehensive review of data-validity problems is needed, and some strong corrective measures should be instituted. Advocacy rather than scientific preferences seems to predominate.

USE

In our opinion, the level of professional communication is dangerously low. There is a great need for better coordination, documentation,

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*J. P. Mayberry, "Principles for Assessment of Simulation Model Validity," in A. I. Siegel, ed., *Proceedings of the Symposium on Computer*

and studies of use at the operational, experimental, and administrative interfaces. It is not enough that a study be finished according to formal contract specifications; what becomes of the study and how it is used are far more important considerations. Learning, both kinds and amounts, must be evaluated so that resources can be expended more rationally. Perhaps it would be worthwhile to declare a moratorium on expenditures for new studies until existing ones have been properly evaluated. Technical weapon evaluations that are either unused, little used, or misused, for example, may be worse than no studies at all. Imprudent management policies (for instance, the high regular turnover of key personnel in some military activities), coupled with uneven documentation standards and procedures, may account for the ineffective use of models. If no one remembers why a particular model was built, for whom, and how it operates, it may be used incorrectly, or, worse, people may start from scratch to build a model that will do the job it was in fact designed to do. If there is little or no documentation, the potential waste becomes a practical certainty.

It is difficult to determine what influence these MSGs have had. As noted, half of them did not even result in a direct briefing. Written comments roughly suggest that they "did the job"; however, little information was given on the importance of the "job" and the policy decisions that depended upon it. Documentation accompanying any MSG should indicate what it has been used for, who has used it, when it was used, and so forth.

The dearth of written scenarios and explicit consideration of intangible and uncertain elements is of concern. It is all too easy to misuse well-specified numerical models by changing the problem context or interpretation. A model that is impressively "good" in one context may be inappropriate in another context, even if specific data for the hard numbers are adequate. That depends upon the skills and interface of those who know the original uses of the model, those who determine the new purposes and applications, those who set the soft numbers, and those who provide the background interpretations. There

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Simulation as Related to Manpower and Personnel Planning, Naval Personnel R&D Laboratory, Washington, D.C., July 1971, pp. 157-165.

is little evidence on how those tasks are being done, if at all. It appears that the engineering, applied-science bias of most of the builders and caretakers we surveyed would make replication of their MSGs risky.

What all of this means can be stated briefly: there is no substitute for people who know their business. One of the real dangers that we perceive is the poverty of the scientific interface between those who know their business and those who are trying to generate business.

The Department of Defense has nurtured a group of specialists who, having made their share of mistakes, are doing some competent and useful work. But there are few communication means by which their knowledge can be shared more broadly with those in the civil sector.

Notwithstanding this emergent professionalism, the tenuousness of much of the data being used, the immature extent and level of validation, and the relative neglect of such important scientific and operational procedures as sensitivity analysis and scrutiny of the appropriateness of work for specific operational environments and scenarios, make it easy to infer that advocacy rather than scientific preferences prevails. Can scientific content be improved and unfounded advocacy be reduced? Generally, the answer is yes, although the problem is difficult.

One desirable innovation would be to make the advocacy process two-sided rather than one-sided as it is now.* For example, the quality of discourse on weapons procurement would be improved if congressional participants as well as DOD proponents had consultant advice and professional assistance. In other words, improve existing methods and procedures for challenging the assumptions and quality of work done in support of any one position, system, or decision. Lawyers and accountants may be able to win debating points from the engineers, generals, and mathematicians, but that suggests a far from rational allocation process, much less an optimal one.

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*The recent discussions between George Rathjens and Albert Wohlstetter on the proposed Safeguard ABM system before the U.S. Senate illustrate the benefits of having both sides on a question technically competent and informed with comparable data. The entire issue on *Operations Research*, Vol. 19, September 1971, is devoted to their intelligent debate.

COSTS

Costing is deficient. Granted, cost accounting is difficult to do in a process as complex as the initiation, production, operation, and evaluation of MSGs; nevertheless, for better management control, some record of cost must be kept on each MSG. It need not be complicated; even crude figures within ±100 percent of the actual would be an improvement over current information.

More than one-third of the respondents, over a range of diverse questions, did not or could not consistently reply to the most elementary cost questions. Those that did respond, moreover, had low confidence in their answers.

Whose responsibility and in whose interest is cost control? Developers have little reason to be interested in costs except as they contribute to their own revenues. Questions about alternative methods to modeling and simulation are seldom explored in the operational setting. Current procedures do not seem to include formal consideration of whether there is a cheaper, easier way to proceed or whether model-building is really the most appropriate technique. The first should be a managerial concern; the second should be dealt with at the technical level.

That responsible persons were unable to supply much rudimentary cost data suggests that cost accounting has been neglected. It is evident that cost data, perhaps conceived of primarily as relating to investment, quickly become separated from the work itself. What results is that users, caretakers, and even builders have but vague notions of cost a year or so after the work has been undertaken.

Curiously, there appears to be a magic (i.e., relatively easily fundable) budget amount between $200,000 and $300,000. Judging from our survey data, it would be better to apply for two separate budgets for two different models at $200,000-$300,000 each than to apply for a budget for one model at $400,000-$600,000. Families of MSGs have been maintained for years with separately labeled components funded separately and used and evaluated independently. Actually, many are merely increments of the same basic work and should be considered as such.

It is interesting that most money is spent where professional visibility and active participation by high-echelon personnel are minimal. That raises an important question about the effectiveness of expenditures. Are we trying to compare incommensurables?

Machine models and simulations appear to favor so-called value-free engineering work and are produced by bright lieutenants, captains, majors, or possibly colonels in cooperation with civilian contractors. Such work can easily lead to larger studies that become briefings for colonels and generals and their civilian counterparts. Information about the context, such as verbal descriptions and scenarios, and details about purposes and limitations of a model are seldom spelled out. Man-machine exercises, in contrast, are frequently used for teaching or training in the staff colleges. As a result, there is some chance that a two- or three-star general or admiral might remember or have learned something as a result of a man-machine exercise he participated in. Such activities may also be used in an experimental laboratory where the personnel employed are not necessarily military and where the purpose is altogether different. As noted, the least expensive activities are the political-military exercises that at one time or another may have commanded the attention of the highest-level personnel. Whether free-form military games accomplish anything besides entertainment is an open question that deserves further study.

Little attention has been paid to what is meant by claims that a certain study has influenced policy. An imaginative briefing by the likes of Herman Kahn or a political-military exercise run by an Albert Wohlstetter with high-level participants may have had more influence on policy than most multi-million-dollar models and simulations. Then again, neither may make any difference. Much depends on the timeliness of the exercise and its relevance to current problems.

Questions like the foregoing must be made explicit. Then it may be possible to take a more objective look at the routine expenditure of millions of dollars for middle-level, engineering-type MSGs.

IV. RECOMMENDATIONS

From our analysis of the survey results, we have identified the following issues as being critical to resolve if the standards of gaming and simulation are to be raised.

ADVOCACY VERSUS SCIENTIFIC VALIDATION

The process of building and using MSGs provides an important illustration of model-builders' neglect of science in the interest of advocacy. As long as model-builders do not question the environment set for them by those soliciting the work, practically any point of view can be supported by selecting appropriate "guesstimates" about the environment. Accordingly, there is a need for open, regular, and more rigorous review of the models, games, and simulations that are being built and used. Procedures should challenge the validity of data inputs that are now so routinely and unquestioningly used.

Communication between civilian and military segments of the profession must be improved. A professional advisory group at the level of Congress or the GAO appears to be desirable to enhance the dialogue between the Congress and DOD.

COST ACCOUNTING

Given the little or no institutional memory about the cost of building, running, updating, and evaluating MSGs, any effort would probably be an improvement over the present poor-to-nonexistent procedures of cost accounting. The accounting definitions and categories we were forced to create for this survey may be useful as a point of departure. At the least, a brief cost dossier should be kept with an MSG throughout its existence.

EXTERNAL REVIEW AND PROFESSIONAL STANDARDS

Professional reviewing is a critical and much-neglected means of quality control. To those who claim that it merely adds an extraneous bureaucratic impediment to "getting the job done," we cite the efficient

and competent efforts of the Army Models Review Committee as evidence to the contrary.* Regrettably, that committee's work was ad hoc and temporary, when persistence is called for.

The Joint Chiefs of Staff might well be able to assume an MSG review function for all the services. What is required are qualified professionals to serve on a long-term, continuing basis and strong incentives to insure adherence to scientific standards of evaluation. Such a group should also deal with questions of standards, such as, When is sensitivity analysis needed? and What constitutes data validation?

DOCUMENTATION

Documentation is largely of uneven quality, not available, or nonexistent. At a minimum, an MSG's documentation should include the following: the program listing; flow charts; variable listings, definitions, and sources; the program deck with comments and caveats about operating quirks and special library or input/output routines; the operator's manual; the programmer's manual; the player's manual if the MSG is man-machine or free-form; the pertinent analysis routines used to reduce data generated by the MSG and to estimate input parameter values for the MSG; appropriate data reflecting what the MSG cost to construct, update, and run; and the register of critical personnel involved in MSG *initiation*--who wanted it built, for what reasons; *production*--the identities of the master modeler and the model team and what validation procedures they used; *operations*--the history of professional review by persons external to the builder-user; and *use*--who used it, when, and with what purpose and outcome.

Many will complain that this list is too long, is burdensome, and would impede the work at hand. Nevertheless, conscientious and consistent attempts to complete it will improve existing management practices and may in time open the way to improvements in the state of the art and the state of knowledge.

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*Army Models Review Committee, *Review of Selected Army Models*, Department of the Army, Washington, D.C., May 1971, Chapter 8.

REDUNDANCY AND STANDARDIZATION

We find no evidence that redundancy is excessive. Communication amoung MSG builders is poor and needs improvement; however, even if it were good, a certain amount of redundancy would be desirable, and that amount does not appear to have been consistently exceeded.

Standardization should not be confused with adherence to professional standards. We recommend strongly against the first, as it is premature. We urge, however, that efforts be made to promote the second.

A CENTRAL CLEARINGHOUSE?

We recommend against the creation of an additional bureaucratic operation for the clearing of work on MSGs. However, there is a legitimate need for a professional focal point, which could be provided by the type of JCS professional review board recommended above.

Work in gaming and simulation is fragmented to an unnecessary and unhealthy extent. We urge the joint usage of MSGs. By that we mean the sharing of MSG construction and use among the military services and government agencies; the scientific replication of MSGs; collective attempts to account for and reduce costs; and the sharing of special overhead charges for large-scale, general-purpose computational systems, even more than is now done via the NMSCCS device. Joint usage promises the more efficient use of scarce professional talent and the diffusion of professional standards. The creation of a JCS Models Review Committee based on the Army prototype would be a step in the right direction.

RESEARCH

Basic research and knowledge is lacking. The majority of the MSGs sampled are living off a very slender intellectual investment in fundamental knowledge. While this is probably not the time to expect much funding for basic research, the need is great for work on topics such as simulation methods, data validation, sensitivity analysis, and statistical tests for simulation outputs. As regards analysis, study is needed on formal models of combat, such as allocation and search game theory. In the "softer" subjects that bear directly on applied MSGs, there is a need for studies of panic behavior (the "breaking point"

hypothesis, for example), threat and confrontation, and especially human factors and motivation. At another level, work is required on basic questions of use, both for particular MSGs and for whole families and classes of MSGs.

The "image" of research needs refurbishment among funders and builders in the professional community. Research appears to be so stigmatized that one can scarcely acknowledge sponsorship of a pure research project without bracing for criticism.

The need for basic research is so critical that if no other funding were available we would favor a plan to reduce by a significant proportion all current expenditures for MSGs and to use the saving for basic research.

MSG SIZE

There is every indication that the larger MSGs have been of little utility. The size, length of time under development, and generality of an MSG all appear to be directly related to the difficulty of controlling, validating, and using it. Undesirable outcomes resulting from changes in personnel, bad documentation, poor conceptualization, and poor professional communication and review are only exaggerated with large MSGs. We recommend that standards for approving the construction of large-scale MSGs be much more stringent than for smaller projects.

We believe that large-scale MSGs tend to lack the capability of handling scenarios and other hard-to-quantify elements. Funds would be better spent on the basic research to acquire that capability than on the premature constuction of large programs.

FREE-FORM AND MAN-MACHINE GAMING

We believe that it is time for an assessment (preferably by military and nonmilitary personnel, "hard" and "soft" scientists) of the role of free-form and man-machine gaming in DOD work on MSGs, relative to that of all-machine simulation. We suspect that free-form gaming deserves more prominence.

Man-machine gaming for operational purposes appears to be relatively expensive and not heavily used. For training and teaching,

both man-machine and free-form gaming appear to have been relatively undersupported.

We recommend that an investigation be sponsored to explore the relationship among multiple uses of MSGs. Specifically, especially given the projected size of the new Naval War College gaming facility, the relationship among training, evaluation, operational, and research uses must be better understood.

GAMING IN THE CIVILIAN SECTOR

In spite of some negative findings, we see distinct growth in the state of the art and the emergence of professional standards. We are troubled, however, by the lack of professional communication between and outside the specialized, in-house model-building shops. It seems likely that many of the mistakes committed in the application of simulation and gaming to DOD problems are about to be re-committed in civil-sector applications.* Given the lack of communication that suggests, it may be fortunate that funding for MSGs from agencies such as HEW and HUD is small relative to that from DOD.

---

*Indeed two pioneering attempts by HUD have been appraised and found wanting in many of the same ways as the MSGs we report on here. The problems are apparently common. See Garry D. Brewer, *The Politician, the Bureaucrat, and the Consultant: A Critique of Urban Problem-Solving*, New York: Basic Books, forthcoming in 1973.

Appendix A

QUESTIONNAIRE: MODELS, COMPUTER MACHINE SIMULATIONS, GAMES, AND STUDIES*

PREFACE

The purpose of this questionnaire is to aid the interested professional in describing, characterizing, and analyzing his game, model, or simulation. It is a first and, hopefully, useful step in the clarification of professional standards in the work on gaming and simulation. Furthermore, the questionnaire is designed so that it might also serve as a device for communicating and cataloging different games and simulations in a format that encourages easy interchange of information.

The questionnaire format has been adopted for three purposes. (1) In the course of our ongoing investigations we expect to use this document as a questionnaire. (2) Stress in design has been to produce a categorization scheme for the description and classification of games and simulation in general. The goals are to help establish professional standards and to explore the possibilities of developing a reasonably good classification and consistent description that covers many games of different varieties. (3) It is our belief that the compiling of a large, consistent sample of many games and simulations for the purposes of analysis, evaluation, information interchange, and the construction of professional standards is overdue. The work involved in doing so is both large and onerous. The handling of large quantities of data calls for at least partially computerized procedures. The format we are presenting here was designed with this type of data processing in mind.

This is the survey instrument, reproduced in its entirety. (It was previously published, by the same authors under the same title, as P-4672, The Rand Corporation, July 1971.) Page numbers have been changed to be in sequence with this report. Responses to many of the questions in Parts I and II are indicated in italics.

This questionnaire had as an original purpose the description and classification of games in general. Because the preponderance of all available resources for models, simulations, and games is spent by the Defense Department and its various derivates, we have redesigned and reorganized the instrument to reflect these activities better. Some questions were reworded, some were added, others were discarded. At this point in the process, separate questionnaires for computer, all-machine models, and for man-machine and manual games were constructed.

These modified questionnaires were applied to ten representative DOD models, simulations, and games. Several Rand Corporation games were also sampled. This "shakedown" prompted another round of evaluation and redesign. The present version of a single questionnaire is the result. Although the emphasis on DOD is evident, we believe that a hard core of generally applicable information remains.

Questionnaire conceptualization and design is a potentially difficult undertaking. This particular questionnaire covers a complex, diverse, changing, and specialized body of knowledge and practice; consequently, the difficulties found in its construction have been formidable. For instance, even at the most primitive definitional level there is little but cloying disagreement. What is a model? What difference is there between a model and a simulation? What is a game and when is it not a model, and vice versa? Indeed the semantic game presently appears to take precedence and to substitute for the real game all too frequently. Other indicators of an unsettled but emerging professionalism abound. What this means is that construction of a questionnaire such as this is hard work; and no matter what results, it will have shortcomings, problems, and probably more than a few errors. We acknowledge the weaknesses and welcome comments, suggestions, and corrections from others concerned with gaming and simulation.

Parts I, II, and IV are designed for all types of models, games, and simulations. Manual and man-machine activities necessitated the additional questions in Part III as well. Further work is in progress in the categorization of questions more specifically aimed at the uses of gaming and simulation for teaching and for experimental purposes. We recognize that this questionnaire cannot be regarded as adequate in providing a means of analysis if the two major uses of a game or simulation are teaching or research alone.

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PURPOSES OF THE QUESTIONNAIRE

1. To give an overall quick picture of the purposes, use, benefits, and costs of DOD activities in gaming, simulation, and the use of models.

2. To provide an initial description and classification scheme for a professional catalog for games, simulations, and models for use in:

    - o Quick professional interchange of information on the characteristics of models.
    - o Aid in construction and estimation of model characteristics for new model-builders.
    - o Aid in the evaluation of previous and current activities.

INTRODUCTION: TERMINOLOGY

The state of the profession is such that no clear agreement on fundamental terms exists in all of the various activities using models, simulations, or games. Acknowledging this fact, we advance the following definitions to provide guides to indicate the type of work this questionnaire covers.

Gaming: A gaming exercise employs human beings acting as themselves or playing simulated roles in an environment which is either actual or simulated. The players may be experimental subjects or participants in an exercise being run for teaching, operational, training, planning, or other purposes. This questionnaire is designed to describe games constructed for these various purposes.

War Gaming: One of the major applications of simulation is war gaming. A war game is defined by the Department of Defense as a simulation of a military operation involving two or more opposing forces and using rules, data, and procedures designed to depict an actual or assumed real-life situation. It is primarily a technique used to study problems of military planning organization, tactics, and strategy.

A war game can be conducted to cover the entire spectrum of war, i.e., politico-military crises, general war, or limited war. The game may be based on hypothetical situations, real-world crises, or current operational plans. Some games are designed for joint operations by two or more military services, some are for use by a single service, and others may be used by individual Army field commanders or even by division or battalion commanders. The level of command at which the game is to be played, of course, influences the type of units to be represented and the scope of operations to be conducted.

There are three types of war games in common use today: the training game, the operational game, and the research game. The training game is the least complex and is designed to provide the participants with decisionmaking opportunities similar to those that may be experienced in combat. The operational game deals with current organizations, equipment, and tactics. It is more complex than the training game, uses inputs that are based on known quantities, and is used to test operational plans. The research game, which is the most complex of the three types of games, requires careful preparation to achieve maximum objectivity and usually is designed to study tactical or strategic problems in a future time frame.

A war game can be accomplished manually, can be computer-assisted, or can be wholly computerized. Manual games are played using symbols, pins, or pieces to represent forces, weapons, and targets on maps, mapboards, and terrain models. A computer-assisted game is a manual game using computerized models, which free the control group from many repetitive and time-consuming computations.

Computer games are based on predetermined procedures. All simulation of conflict is done by the computer in accordance with the detailed instructions contained in the computer program. The primary advantage of computer gaming is that the same situation can be simulated many times under differing conditions, to observe variability of results. A computer war game requires the use of a war game model (i.e., computer program), which contains all the rules, procedures, and logic required to conduct the game.

Simulation: Simulation involves the representation of a system or organism by another system or model, which is designed to have a relevant behavioral similarity with the original system. Games utilize a simulated environment or simulated roles for the players or both. In general, all games are simulations. However, it is not particularly useful to use the reverse categorization. In other words, not all simulations are usefully regarded as games. Computer simulations stimulating conflict or cooperation (such as completely computerized battle models) are usefully considered as games. Possibly, so are some logistic or resource allocation models where the single (automated or live player) team may be regarded as struggling against a statistical or strategic opponent called "Nature." The borderline is not hard and fast; however, we would expect to leave out a straight industrial production scheduling machine simulation from our category, for example.

Computer simulation is an analytical technique which involves the use of mathematical and logical models to represent the study and behavior of real-world or hypothetical events, processes, or systems over extended periods of time.

Simulation provides the means for gaining experience and for making and correcting errors without incurring the costs or risks of actual application. It offers opportunities to test theories and proposed modifications in systems or processes; to study organizations and structures; to probe past, present, and future events; and to utilize forces that are difficult or impracticable to mobilize.

Simulation therefore is of value both as an educational device and as a means of discovering improved methods.

Simulation should be used when (1) it is either impossible or extremely costly to observe certain processes in the real world, (2) the observed system is too complex to be described by a set of mathematical equations, (3) no straightforward analytical technique exists for solution of appropriate mathematical equations, and (4) it is either impossible or very costly to obtain data for the more complicated mathematical models describing a system.

On the other hand, simulation should not be used when (1) simpler techniques exist, (2) data are inadequate, (3) objectives are not clear, (4) there are short-term deadlines, or (5) the problems are minor.

Contract Studies & Analyses: The words "studies and analyses," as used in this questionnaire, refer to those studies and analyses done by contract or by grant and which deal with the systematic and critical examinations of various subjects. Studies and analyses often require advanced analytical techniques to integrate a variety of factors and to evaluate data. Their purpose is to provide greater understanding of alternative organizations, tactics, doctrines, policies, strategies, procedures, systems, and programs.

Model: Conducting a computer or computer-assisted war game or related simulation requires the use of a computerized model. As used in this context, a model is a document or program containing all rules, methodology, techniques, procedures, and logic required to simulate or approximate reality. A computerized model is a computer program or series of programs, designed to simulate the logic of actions or interactions of an environment or a context and provide the results to player personnel for subsequent analysis.

MSG: To avoid the ambiguities of "local" definitional usage peculiarities, we have elected to use the shorthand version "MSG" to stand for model/simulation/game in the remainder of the questionnaire. This, we hope, will facilitate present communications in light of the still unresolved, serious definitional problems. The respondent is encouraged to substitute for himself whatever local term seems appropriate when he encounters the "MSG" label.

LABELS/ADMINISTRATION

(For Office Use Only)

1-0 INTERNAL ID TAG: (_____)

2-0 PUBLICATION ID NUMBER: (_____)
2-1 PUBLICATION ID NUMBER: (_____)
2-2 PUBLICATION ID NUMBER: (_____)
2-3 PUBLICATION ID NUMBER: (_____)
2-4 PUBLICATION ID NUMBER: (_____)

3-0 ABSTRACTED: NO
3-1 ABSTRACTED: YES
3-2 ABSTRACTED: CRITIQUE
3-3 ABSTRACTED: AUTHOR ABSTRACT

INSTRUCTIONS

In filling in this questionnaire, as many questions as possible have been designed to be answered by marking one or more relevant categories in each question (e.g., circling or marking a number). This should help to increase the speed with which the questions can be answered. Furthermore, it is easier to use computer assistance to process questions of this type. However, in many instances the words used for the categories do not quite reflect the properties of the game, simulation, or study being characterized.

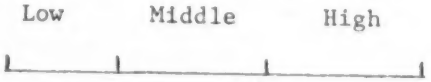
The respondents are requested to mark the most relevant categories, then to make any written commentary modifying the answer or suggesting an improvement of the question.

Notes are provided on pages opposite the questions.

Use one questionnaire for each man-machine game or simulation, machine (or analogue) simulation, or study. Parts I, II, and IV of this questionnaire are designed to be answered for *all* MSGs. Part III is added to accommodate the particular characteristics of man-machine and manual games.

Note #1: Please note the amount of time taken to fill in each questionnaire and return to Question #1 to record this information upon completion of a questionnaire.

Note #2: To the right of each question there is a three-interval confidence scale. If you are certain of your answer mark an "X" at the extreme right on the scale. Please mark your confidence level for *all* questions where the scale is indicated.



Confidence Level

On a scale of 0-1 your answers will be interpreted as follows:

Virtually certain	.9 - 1
High	.7 - .9
Middle	.3 - .6
Low	0 - .3

If you wish you may use the scale in either of two ways, by using an X,

or by putting in a number.

"Certain" should be recorded as follows:

MODELS AND SIMULATIONS

The word "model" is sometimes used to refer to a program that might be called a general-purpose subroutine in the sense that it, together with other models, may be run together in a simulation. Thus, many simulations may be specific "one-shot" configurations of models operated only to answer a specific question. Sometimes a large-scale program may be called a simulation and is used more than once with different inputs or even with models or subroutines added. If you feel that an important technical distinction concerning your MSG has not been made, comment accordingly and note where it might influence an answer.

BUILDERS AND USERS

The first section of this questionnaire is oriented more toward those who use the outputs from an MSG applied to a particular problem or study than to those who designed or built the MSG. A user who is reasonably well acquainted with the technical aspects of the work may be able to answer the second section of the questionnaire. However, if it appears necessary to have another individual or group answer the second part, this should be done and the second group should be identified.

Part I: Basic Information on Purposes, Use, Benefits, and Costs

NOTE: Coding data, response data, and other information not in the original questionnaire appear in italics.

*1-0 QUESTIONNAIRE TIME (_____)

[Those Questions marked * are of particular importance and therefore extra care and accuracy are called for.]

#2. Simulation/Study/Model and Author Name Tag: This calls for the name of the first or primary effort, list name of the agency or firm(s) that built the game, simulation or model (MSG), and the name of the two or three major authors or designers.

The agency or authority is the official group ordering the work. The sponsor calls for the name of the officer or official responsible for ordering the work.

*2-0 SIMULATION/STUDY/MODEL NAME (_____)

DESIGNER BUILDING AGENCY OR FIRM (_____
_____)

AUTHOR(S) NAME(S) (_____)

AGENCY OR AUTHORITY(IES)(_____)

(_____)

SPONSOR(S) OF WORK: NAME(S)(_____)

CATEG1, 3/10-11†			*Response (%)*
*3-0	CATEGORY:	MODEL	*46.2*
3-1	CATEGORY:	SIMULATION	*34.8*
3-2	CATEGORY:	MAN-MACHINE GAME	*8.3*
3-3	CATEGORY:	MANUAL GAME	*2.3*
3-4	CATEGORY:	MATHEMATICAL ANALYSIS OR STUDY	*3.0*
3-5	CATEGORY:	OTHER (_____) Specify	*4.5*
	NR††	.....	*0.8*

†*This information, which is listed for various questions throughout the questionnaire, indicates the code name of the variable being studied and its position in the keypunch deck. Hence, in this case, the code name is CATEG1, occupying card 3, columns 10 and 11. See Appendix C for the complete codebook. The responses are percentages of 132.*

††*No response.*

#4. Respondent's Role: [Describe your role with respect to this game or simulation, e.g., participant/player/funder/user/designer/ implementor/caretaker, etc.]

RESROL1, 3/12-14

*
4-0 RESPONDENT'S ROLE: FUNDER OR SPONSOR *14.4*
4-1 RESPONDENT'S ROLE: USER *31.8*
4-2 RESPONDENT'S ROLE: DESIGNER OR BUILDER *31.1*
4-3 RESPONDENT'S ROLE: PLAYER *0.0*
4-4 RESPONDENT'S ROLE: CARETAKER *13.6*
4-5 RESPONDENT'S ROLE: CONTROL TEAM OR REFEREE *1.5*
4-6 RESPONDENT'S ROLE: OTHER (Specify) *7.6*

[COMMENT: Give or Attach a Brief Job Description]

5-0 LENGTH OF TIME YOU HAVE BEEN ACQUAINTED WITH THIS WORK (_____)

6-0 IF LESS THAN 3 YEARS, LIST LAST TWO ASSIGNMENTS (_____ _____)

*7-0 RESPONDENT'S INFORMATION: NAME (_____)
RANK, TITLE AND POSITION: (_____)
(_____)

SPECIAL QUALIFICATIONS AND/OR EDUCATION RELEVANT TO THIS TASK: **(Describe)**

*8-0 MAJOR STATED GENERAL PURPOSE OF YOUR MODEL, GAME, OR SIMULATION:

[If you were given a few minutes to describe the project to a senior official, what could you say? (This could be one to two double-spaced, typed pages, or if you have a reasonably short written summary, simply attach a copy.)]

9-0 SPECIFIC PURPOSES:

[Name two specific examples of questions or operational problems this MSG has been used to answer.]

[NOTE: If more than one category applies, circle more than one answer in your reply.]

#10. Purpose: This question is somewhat redundant with #8 and #9. However, here you are asked to conform to a few-word description of the work. It is important to note the distinctions made in #10-3 and #10-4. Some strategic games have introduced diplomatic considerations and international bargaining. These would fall under the category #10-3. Other simulations and gaming exercises may be explicitly concerned with internal economic and domestic repercussions. These would more appropriately be classified under #10-4. It is of course possible to have exercises that may be classified under more than one category, such as both #10-3 and #10-4.

PURP1, 3/17-19

*

10-0	PURPOSE:	TECHNICAL EVALUATION	*44.7*
10-1	PURPOSE:	DOCTRINAL EVALUATION	*18.2*
10-2	PURPOSE:	FORCE STRUCTURE EVALUATION	*28.8*
10-3	PURPOSE:	MILITARY-DIPLOMATIC ANALYSIS/INTERNATIONAL RELATIONS	*0.8*
10-4	PURPOSE:	MILITARY-POLITICAL-ECONOMIC ANALYSIS/DOMESTIC RELATIONS	*0.0*
10-5	PURPOSE:	TRAINING/EDUCATION	*0.0*
10-6	PURPOSE:	RESEARCH METHODOLOGY	*1.5*
10-7	PURPOSE:	OTHER (Specify)	*6.1*

10CL, 3/20

NR	Low	Middle	High	*Certain*
3.0	*3.8*	*13.6*	*53.9*	*26.5*

Confidence Level

#11. Classification: Often simulations or models per se are unclassified. However, when military planning factors are added they then become secret or may have an even higher classification. This means that for some there will be supportive documents that fall into many classifications. #11-5 Proprietary. We include business classifications, such as simulations run internally by corporations and classified as corporate confidential; furthermore, proprietary implies that the documents are made available only by the proprietor to whomever he sees fit.

CLASWO, 3/21

11-0	CLASSIFICATION (WITHOUT INPUTS):	NA; UNCLASSIFIED	*72.0*
11-1	CLASSIFICATION (WITHOUT INPUTS):	FOUO	*6.8*
11-2	CLASSIFICATION (WITHOUT INPUTS):	CONFIDENTIAL	*12.9*
11-3	CLASSIFICATION (WITHOUT INPUTS):	SECRET	*5.3*
11-4	CLASSIFICATION (WITHOUT INPUTS):	TOP SECRET	*0.0*
11-5	CLASSIFICATION (WITHOUT INPUTS):	PROPRIETARY	*3.0*
11-6	CLASSIFICATION (WITHOUT INPUTS):	OTHER (Specify)	*0.0*

CLASWI1, 3/22-23

12-0	CLASSIFICATION (INPUT DATA, OTHER)*:	NA; UNCLASSIFIED ..	*12.1*
12-1	CLASSIFICATION (INPUT DATA, OTHER)*:	FOUO	*0.0*
12-2	CLASSIFICATION (INPUT DATA, OTHER)*:	CONFIDENTIAL	*6.8*
12-3	CLASSIFICATION (INPUT DATA, OTHER)*:	SECRET	*59.1*
12-4	CLASSIFICATION (INPUT DATA, OTHER)*:	TOP SECRET	*11.4*
12-5	CLASSIFICATION (INPUT DATA, OTHER)*:	PROPRIETARY	*0.0*
12-6	CLASSIFICATION (INPUT DATA, OTHER)*:	OTHER (Specify) ...	*8.3*
	NR		*2.3*

*[DESCRIBE]

#13. Professional Review. What professional reviewing procedures are used to check periodically on the validity of this MSG, its use and its inputs? Is there any formal reviewing group external to both the users and producers?

PROREV, 3/24

*13-0	PROFESSIONAL REVIEW DONE?	*NO*	*40.2*
		YES	*49.2*
		NR	*10.6*

BY WHOM? (Specify)

REVDAT, 3/25

WHEN LAST DONE? (_____):	*Not done*	*40.9*
	< 6 months	*18.2*
	6-12 months	*13.6*
	13-24 months	*6.1*
	25-36 months	*4.5*
	> 36 months	*4.5*
	NR	*12.1*

#14. MSG Parent or Antecedents; The first three subcategories ask for information on a formal model parent, i.e., existing model, simulation, or game that is acknowledged as the direct parent of the model categorized. Even for original models, there in general was a prior work or specific piece of literature or several models and pieces of literature which provided the suggestion or stimulation (positive or negative) for the construction of this model.

MSGPAR, 3/26

14-0 MSG PARENT OR ANTECEDENTS, DIRECT: NONE *37.9*
14-1 MSG PARENT OR ANTECEDENTS, DIRECT: ONE *37.9*
14-2 MSG PARENT OR ANTECEDENTS, DIRECT: MORE THAN ONE (Specify) *20.5*
14-3 MSG MODEL PARENT OR ANTECEDENTS, INDIRECT, NUMBER (____) *3.8*

14CL, 3/27

NR	Low	Middle	High	*Certain*
20.5	*4.5*	*12.1*	*43.9*	*18.9*

Confidence Level

15-0 NAME DIRECT PARENTS (_____)
(_____)

16-0 NAME INDIRECT ANTECEDENTS: (_____)

*#17. Development Initiation Date: Give date or approximate date to nearest month or year.

*17-0 DEVELOPMENT INITIATION DATE: (_____)

*#18. Use Initiation Date: This means the first production run.

18-0 USE INITIATION DATE: (_____)

DEVTM1, 3/29

ELAPSED TIME OF DEVELOPMENT (#18 - #17):

< 3 months	*7.6*
3-6 months	*19.7*
7-12 months	*21.2*
13-18 months	*15.2*
19-24 months	*8.3*
25-30 months	*5.3*
31-36 months	*3.8*
37-42 months	*3.8*
> 42 months	*3.0*
NR	*12.1*

#19. MSG Spinoff. This refers to models, games or simulations for which this MSG was a parent. We also count the same MSG used elsewhere by a different agency, authority, or group in which case "same" would be entered as a name of a spinoff.

MSGPRO, 3/28

19-0 MSG SPINOFF: NONE *60.6*
19-1 MSG SPINOFF: ONE OR MORE (Specify number)
1 ..... *16.7*
> 1 ..... *17.4*
NR *5.3*

Low	Middle	High

Confidence Level

20-0 NAMES OF ONE OR TWO SPINOFFS: (_____)

MODEL/SIMULATION/GAME PRODUCTION AND PURPOSE

#21. Funding: In some instances, especially when individuals do a fair amount of work in their "spare time," one should note more than one funding source. Multiple funding sources may also arise when a game is started at one location and completed, run, or used at another location. NSF would be classified as #21-1 and #21-9.

WHO1, 3/30-33

21-0	FUNDING SOURCE:	(_____)	*0.0*
21-1	FUNDING SOURCE:	FOUNDATION (_____)	*0.8*
21-2	FUNDING SOURCE:	PRIVATE (BUSINESS, SELF, MISC.) (____)	*2.3*
21-3	FUNDING SOURCE:	ARPA (_____)	*0.0*
21-4	FUNDING SOURCE:	JCS (_____)	*6.8*
21-5	FUNDING SOURCE:	USA (_____)	*42.4*
21-6	FUNDING SOURCE:	USAF (_____)	*17.4*
21-7	FUNDING SOURCE:	USN (_____)	*25.0*
21-8	FUNDING SOURCE:	OTHER DOD (_____)	*2.3*
21-9	FUNDING SOURCE:	OTHER US GOVERNMENT (_____)	*0.8*
21-10	FUNDING SOURCE:	UNIVERSITY (_____)	*2.3*
21-11	FUNDING SOURCE:	OTHER (_____)	*0.0*

#22. MSG Production: #22-2 For profit includes the possibility that a game is built by a for-profit organization but not necessarily used as a product. For example, it might be used for research or for internal training purposes. The producer may be a for-profit organization building for the DOD.

WHODID1, 3/34-35

22-0	MSG PRODUCTION:	PRIVATE, INDIVIDUAL	*0.0*
22-1	MSG PRODUCTION:	UNIVERSITY	*5.3*
22-2	MSG PRODUCTION:	FOR-PROFIT	*28.0*
22-3	MSG PRODUCTION:	ARMED FORCES	*44.7*
22-4	MSG PRODUCTION:	NOT-FOR-PROFIT	*22.0*

#23. MSG Initiation: #23-1 Model builders/researchers refers to a project where the original proposal was initiated with the individual specifically interested in researching and building the simulation. Much of MSG/research work falls under this category. The researchers propose the construction of the MSG to a funding or a sponsoring agency. #23-2 MSG/users may initiate a proposal for construction. For example, a decision may be made to run a model at an institution which has a special facility. The request is made to the constructors and when the simulation is ready, those who requested it actually participate in its operation.

#23-3 There may be a request made internally to an organization from a management group for the construction of a model to be used by other individuals in the organization. In other words, "a" requests "b" to construct a model to be used by "c." This is a fairly common managerial structure. #23-4 An agency outside of an organization which intends to use a model may request the organization to build it for the agency. For example, the local governmental group may decide to have several sessions with an urban development simulation. They may request private corporations to build it for them and may then use the model for training, operational, or advocacy purposes. #23-5 An outside agency may request a different institution to both build and use a simulation for their purposes. In this case, the sponsor is really only interested in the results and not in the specific aspects of the model. For example, in certain simulations or computerized battle models, the question posed may be "What are the characteristics of this weapon under a given set of circumstances?" The sponsor may approve having a simulation built and constructed; however, the sponsor's technical interest per se, is only limited to the results and not to its operation.

INITIA, 3/36

*

23-0	MSG INITIATION:	NA; UNKNOWN	*4.5*
23-1	MSG INITIATION:	MODEL BUILDERS/RESEARCHERS	*18.2*
23-2	MSG INITIATION:	MODEL USERS INTERNAL TO ORGANIZATION ...	*30.3*
23-3	MSG INITIATION:	NON-USER, INTERNAL TO ORGANIZATION	*10.6*
23-4	MSG INITIATION:	USER, EXTERNAL TO ORGANIZATION	*23.5*
23-5	MSG INITIATION:	NON-USER, EXTERNAL TO ORGANIZATION	*12.9*

#24. Initiator Purpose: #24-1 The differentiation we wish to make between the terms "teaching" and "training" is that training is more concerned with "how to" whereas teaching is more concerned with "why." In many instances teaching and training blend imperceptibly into each other. #24-2 Analysis. This meaning is to be distinguished from #24-5 research/theory development. Analysis means the honest grappling with a specific question or set of questions related to a given problem. The distinction is best made between operational modeling, where a purpose of analysis is fairly well known, and academic modeling, where research and theory development are more the norm.

INPURP1, 3/37-39

24-0	INITIATOR PURPOSE:	NA; UNKNOWN	*0.0*
24-1	INITIATOR PURPOSE:	TEACHING/TRAINING	*1.5*
24-2	INITIATOR PURPOSE:	ANALYSIS/DIAGNOSTICS	*81.8*
24-3	INITIATOR PURPOSE:	OPERATIONAL	*10.6*
24-4	INITIATOR PURPOSE:	EXPERIMENTAL	*0.8*
24-5	INITIATOR PURPOSE:	RESEARCH/THEORY DEVELOPMENT	*5.3*
24-6	INITIATOR PURPOSE:	POPULARIZATION, ADVOCACY	*0.0*
24-7	INITIATOR PURPOSE:	OTHER (_____)	*0.0*

24CL, 3/40

NR	Low	Middle	High	*Certain*
4.5	*4.5*	*12.1*	*59.1*	*19.7*

Confidence Level

#25. Specificity of Purpose of Funding Source: The specificity of purpose of the funding source will in general depend heavily upon whether or not the funding source was also the initiator of the game project. For example, a proposal may be made to ARPA to study unconventional warfare. They will sketch out certain aspects of their proposal and more or less what they are going to do. The decision to fund this will be based upon whether or not the group appears to be competent and the work seems to be "reasonable," and a considerable amount of leeway will be left for the group's actual work. Such a situation would fall under #25-2 moderately specified or #25-3 diffusely specified. On the other hand, there may be a specific request from a government agency to test a specific piece of equipment and to use a study or simulation to report on the quality of this equipment.

SPCPRP, 3/41

25-0	SPECIFICITY OF PURPOSE OF FUNDING SOURCE: NA; UNKNOWN ..	*18.2*
25-1	SPECIFICITY OF PURPOSE OF FUNDING SOURCE: TIGHT	*25.0*
25-2	SPECIFICITY OF PURPOSE OF FUNDING SOURCE: MODERATE	*40.9*
25-3	SPECIFICITY OF PURPOSE OF FUNDING SOURCE: DIFFUSE	*14.4*
	NR	*1.5*

25CL, 3/42

NR	Low	Middle	High	*Certain*
6.1	*6.1*	*29.5*	*42.4*	*15.9*

Confidence Level

#26. Best Alternative Procedures. Imagine that the objectives of the simulation must be achieved by a different means. It might appear that to check none and then to check something else would be mutually inconsistent. However, if the MSG is used for more than one purpose this could easily arise. For example, in a MSG used for experimentation there may be no alternative for the experiment, yet the model may also be used for teaching. In this case, lectures or case studies would be reasonable alternatives.

ALTPRO1, 3/43-44

26-0	BEST ALTERNATIVE PROCEDURE: NA; UNKNOWN	*10.6*
26-1	BEST ALTERNATIVE PROCEDURE: NONE OR VIRTUALLY NONE	*22.0*
26-2	BEST ALTERNATIVE PROCEDURE: LECTURES	*0.0*
26-3	BEST ALTERNATIVE PROCEDURE: CASE STUDIES/HISTORY	*11.4*
26-4	BEST ALTERNATIVE PROCEDURE: ANALYSIS	*43.2*
26-5	BEST ALTERNATIVE PROCEDURE: EXPERIENCE	*6.8*
26-6	BEST ALTERNATIVE PROCEDURE: GAMING	*5.3*
	NR	*0.8*

#27. Major Use of MSG: Select the appropriate categories from the list below. Also provide written commentary to explain what you mean by the categories selected, i.e., give "for instances."

USE1, 3/45-47

27-0	MAJOR USE OF MSG:	NA; UNKNOWN	*1.5*
27-1	MAJOR USE OF MSG:	TEACHING/TRAINING	*3.0*
27-2	MAJOR USE OF MSG:	ANALYSIS/DIAGNOSTICS	*78.5*
27-3	MAJOR USE OF MSG:	OPERATIONAL	*3.8*
27-4	MAJOR USE OF MSG:	EXPERIMENTAL	*0.8*
27-5	MAJOR USE OF MSG:	RESEARCH/THEORY DEVELOPMENT	*4.5*
27-6	MAJOR USE OF MSG:	POPULARIZATION, ADVOCACY	*0.0*
27-7	MAJOR USE OF MSG:	OTHER (_____)	*0.0*
	NR		*0.8*

27CL, 3/48

NR	Low	Middle	High	Certain
3.0	*3.0*	*14.4*	*58.3*	*21.2*

Confidence Level

*#28. Analysis Procedures: Explain, providing for instances, the type, amount, and rigor of analytic procedures used on the output of this MSG.

Low Middle High

Confidence Level

#29. Judged Effectiveness of Best Alternative Procedure: This is for the main purpose of the MSG. By main purpose of the MSG we mean the main use that in fact has been made of it. Initiator purpose had the possibility of alternative procedures for more than one use. In answering this question we restrict ourselves only to the major use.

29-0 JUDGED EFFECTIVENESS, BEST ALTERNATIVE PROCEDURE: (_____)

Low Middle High

Confidence Level

#30. Number of Briefings: Total number to date based on this MSG.

BRIEF, 3/49

*30-0	NUMBER OF BRIEFINGS:	UNKNOWN	*42.4*
30-1	NUMBER OF BRIEFINGS:	(Specify)	
	0		*11.4*
	1-3		*11.4*
	4-6		*8.3*
	7-9		*0.8*
	10-12		*5.3*
	13-15		*1.5*
	16-18		*0.8*
	> 18		*18.2*

#31. Level of Briefing: By level of briefing we refer to organization and organizational level and a description of the personnel level involved. For example, number and rank of generals or senior government officials present.

*31-0 LEVEL OF BRIEFING: [Describe]

#32. Purpose of Briefing: Identify and state purpose of two most important briefings, i.e., what decisions depended on this MSG?

*32-0 PURPOSE OF BRIEFING: [Describe]

#33. Importance of MSG to Decision: What impact did MSG have on decision just noted? Describe specifically.

*#34. Measure of Benefits: Specify what you regard as a reasonable measure of benefits and success from this MSG.

MSG PRODUCTION COSTS

#35. Direct Costs to Build: Under this category we mean actual expenditures of money earmarked for the purposes of developing this particular game, formal pay for working time, and measures attributed to the cost of the game. In many instances where there is a great amount of informal work done, the direct cost for the development of the game may be zero, although the indirect and unallocated costs may be enormous. For example, the UCLA business game was developed heavily by the use of faculty time which was not particularly assigned to game building. Many university games have this property. Many games built in-house to an institution without direct contractual assistance also have this property. Thus, the question should be construed as one of finding out when direct monies were assigned for the purpose of game construction.

CSTDIR, 3/50

35-0 DIRECT COSTS TO BUILD: (Specify to nearest $10,000)

< $43K	*19.7*
$50-$93K	*17.4*
$100-$243K	*15.6*
$250-$493K	*6.8*
$500-$743K	*6.1*
$750-$993K	*2.3*
$1-$2.49 million	*2.3*
NA-unknown-NR	*31.8*

35CL, 3/51

NR	Low	Middle	High	*Certain*
13.6	*10.6*	*30.3*	*38.6*	*6.8*

Confidence Level

#36. The question concerning funding for development and building is specifically directed at the accounting question of what money has been formally assigned to the effort concerning a specific model, simulation, or game. Thus it will almost always be an underestimation of cost.

DIRFDS, 3/54

36-0	DIRECT FUNDING TO BUILD: NO	*47.7*
36-1	DIRECT FUNDING TO BUILD: YES	*43.9*
	NR	*8.3*

37-0 AMOUNT OF FUNDING TO BUILD: (Specify)

37CL, 3/56

NR	Low	Middle	High	*Certain*
36.4	*8.3*	*19.7*	*28.8*	*6.8*

Confidence Level

#38. Total Costs: Direct, Indirect, Imputed, and Unimputed: The ranges are purposely kept relatively wide open because of the extreme difficulties in accurately judging the costs. In some cases a variance of 100% or more is to be expected. This will probably be a rather surprisingly large number if one is honest with himself. There is an obvious political problem here. Many of the unimputed costs would in the course of time have an opportunity cost of zero. Furthermore, to a great extent many of the unimputed costs are extra hours of work put in by oneself and not paid for. Hence they do not necessarily come out of anybody's budget or funding. They might be called the "Out of Hide Costs."

TOTCST, 3/57

*38-0 TOTAL COSTS TO BUILD: DIRECT, INDIRECT, IMPUTED, UNIMPUTED: (Specify to nearest $10,000)

< $49K	*23.5*
$50-$99K	*14.4*
$100-$249K	*16.7*
$250-$499K	*12.9*
$500-$749K	*3.8*
$750-$999K	*3.8*
$1-$2.49 million	*5.3*
$2.5-$5 million	*0.8*
NA-unknown-NR	*18.3*

38CL, 3/58

NR	Low	Middle	High	*Certain*
15.2	*26.5*	*37.9*	*15.2*	*4.5*

Confidence Level

MODEL/SIMULATION/GAME OPERATING COSTS AND OPERATIONS

#39. Under costs to operate we include professional time, support time, set-up time, computer time, and experimental subject or participant time together with overhead. In many cases many of these items are provided free. As we are discussing actual expenditures, the estimates we will be asking for will be gross underestimates.

There is possibly more variability in operating costs than in building costs for some types of games. The variability comes in the way player time is counted as a cost as well as facilities' use and operator's time. For example, with many business games played at universities it would appear that the financial costs are zero, as the professorial and student time is not regarded as a direct cost and in some instances computation does not appear as a directly imputed cost, and the use of facilities which would otherwise be unoccupied is deemed to be free. Any attempt to replicate that game in an environment that does not have these features may be extremely costly.

A political military exercise is usually run as an individual affair, and we should consider further replications even though they might be regarded as part of the same experiment as separate items. With educational games or time-shared experiments, costs are calculated based on individual game or subject use. For simulation the cost to operate is the cost to explore the answer to a typical question. This is relatively vague, but an upper bound would be the amount of exploration that might result in a small separate publication.

CSTOPS, 3/59

*39-0 ANNUAL COST TO OPERATE, GROSS: (Comment, if necessary.)

Year	Cost	
19__	_____	
19__	_____	
19__	_____	Specify for last five years.
19__	_____	
19__	_____	

< $9K	*23.5*
$10-$24K	*16.7*
$25-$49K	*7.6*
$50-$74K	*6.8*
$75-$99K	*2.3*
> $100K	*10.6*
NR	*32.6*

39CL, 3/60

NR	Low	Middle	High	*Certain*
25.8	*22.7*	*33.3*	*12.9*	*5.3*

Confidence Level

#40. Cost to Operate, Single Use: What does it cost for a single use of the MSG, assuming only minor or no variations in input values? For example, name such a use and date it approximately. By use, we mean for a single study effort. (This of course may vary, but give an average estimate.)

CSTRUN, 3/61

*40-0 COST TO OPERATE, SINGLE USE:

< $9K	*49.2*
$10-$24K	*9.8*
$25-$49K	*2.3*
$50-$74K	*0.8*
$75-$99K	*2.3*
> $100K	*3.6*
NR	*31.8*

#41. Annual Update Costs: If the model is under continuous development, what are the annual costs of these activities, over and above "normal" operating costs?

CSTUP, 3/62

*41-0 ANNUAL UPDATE COSTS, TOTAL DOLLARS: (_____)

< $9K	*27.3*
$10-$24K	*6.8*
$25-$49K	*13.6*
$50-$74K	*2.3*
$75-$99K	*1.5*
> $100K	*2.3*
NR	*46.2*

41-1 ANNUAL UPDATE COSTS, PROFESSIONAL MAN-YEARS: (_____)
41-2 ANNUAL UPDATE COSTS, PROGRAMMER MAN-YEARS:(_____)

	NR	Low	Middle	High	Certain
41CL, 3/63	27.3	12.3	27.3	25.0	7.6

Confidence Level

#42. Operational Life Span (to date): By operational life span we mean the period starting after development is complete, beginning with the first operational use of the model to the period when it and its analysis or post-run exposition are set aside, having served their purpose.

If a model, simulation,or game that has been in more or less continuous use is still in operation, both that length of time of operation and the fact that it is still operational should be indicated.

OPLIF1, 3/64

*42-0 OPERATIONAL LIFE SPAN (TO DATE): (Specify)

< 3 months	9.1
3-6 months	7.6
7-12 months	8.3
13-18 months	6.8
19-24 months	14.4
25-30 months	3.0
31-36 months	8.3
37-42 months	0.8
> 42 months	23.5
NR	18.2

	NR	Low	Middle	High	Certain
42CL, 3/65	12.1	3.8	18.2	38.6	27.3

Confidence Level

#43. Still Active?: By this we mean, "Is the MSG in its original or mildly modified form still actively being used for production runs?" We contrast this with a serious revision that has resulted in either a new name or an appellation such as Mark II, or Mod III, and so on.

ACTIVE, 3/66

*43-0 STILL ACTIVE?: NO 27.3
43-1 STILL ACTIVE?: YES 65.2
NR 7.6

	NR	Low	Middle	High	Certain
43CL, 3/67	9.8	0.8	6.1	50.8	32.6

Confidence Level

*44-0 MODEL USERS:

[Specify all agencies who directly use the MSG outputs by full name (not military abbreviations); indicate the prime user.]

* #45. Operational Use: Annual Frequency: By this we are trying to find out how many times this MSG is actually exercised or run annually. Specify for the last five years.

Year	Number of Times
19__	_____
19__	_____
19__	_____
19__	_____
19__	_____

OPFRQ1, 3/68

Not operational	*16.7*
1-5	*23.5*
6-10	*6.8*
11-15	*4.5*
16-20	*1.5*
21-25	*3.0*
26-50	*7.6*
51-100	*9.1*
> 100	*15.9*
NR	*11.4*

EXPUSE, 3/69

46-0	EXPERIMENTAL USE: NO	*76.5*
46-1	EXPERIMENTAL USE: YES	*17.4*
	NR	*6.1*

#47. Experimental Example: If 46-1, i.e., "yes," give a for instance. [Describe]

#48. Experimental Purpose, Initial: Was this MSG designed originally for experimental use?

EXPRP, 3/70

48-0	EXPERIMENTAL PURPOSE, INITIAL: NO	*86.4*
48-1	EXPERIMENTAL PURPOSE, INITIAL: YES	*9.8*
	NR	*3.8*

EDUSE, 3/71

49-0	EDUCATIONAL USE: NO	*91.7*
49-1	EDUCATIONAL USE: YES	*5.3*
	NR	*3.0*

#50. Educational Example: If 49-1, i.e., "yes," give a for instance. [Describe]

#51. Educational Purpose, Initial: Was this MSG designed originally for educational use?

EDPRO, 3/72

51-0	EDUCATIONAL PURPOSE, INITIAL: NO	*91.7*
51-1	EDUCATIONAL PURPOSE, INITIAL: YES	*1.5*
	NR	*6.8*

#52. Transferability of MSG Use: #52-0 is a model not intended for transfer. An example of such might be a classified simulation run to test for some particular parameter value and dispensed with after the runs; or a study or simulation may be extremely classified with only one user in mind. #52-1 This would be something like chess or Go where once the rules have been transmitted, one could take a piece of paper, draw the board, obtain some stones, and play. In general, a game of this variety can be transferred immediately at little or no cost. #52-2 An example of a game in this category would be a game that is not overly complex, is extremely well documented and produced, and is generally available. The games Simsoc or Whifn'proof or Summit or Democracy would all fit into this category.
52-3 Middling would cover simulation games such as the UCLA business game where the size of the program is not enormous and computer requirements are such that, at least in the United States, many institutions would have the facilities. Furthermore, the documentation is reasonably good. To get it operating, such a game would require one or two months, taking into account telephone calls, time delays in the mails, etc.
52-5 Simulations that are extremely difficult to travel are ones that depend upon specific facilities and crews of experienced individuals or that are enormous in computational size. For that matter they may not be computer games, but have become so large that they should be regarded more as institutions rather than games. Examples of such are METRO, The Rand Logistic Lab experiments, TEMPER, and the Carnegie Tech game. The reasons why these cannot travel are different; however, in each case the amount of work required to transfer the operation is enormous.

TRANSU, 3/73

*

52-0	TRANSFERABILITY OF MSG USE: NOT INTENDED FOR TRANSFER ..	*10.6*
52-1	TRANSFERABILITY OF MSG USE: GENERALLY	*18.2*
52-2	TRANSFERABILITY OF MSG USE: MODERATE DIFFICULTY	*17.4*
52-3	TRANSFERABILITY OF MSG USE: MIDDLING DIFFICULTY	*26.5*
52-4	TRANSFERABILITY OF MSG USE: DIFFICULT	*18.2*
52-5	TRANSFERABILITY OF MSG USE: EXTREME DIFFICULTY	*7.6*
	NR	*1.5*

[Describe whether transferability just indicated pertains to any of the following situations: (1) use by another person or organization at a new site, (2) use by the same developer/designer/builder at a new site, or (3) use by another person or organization at site where MSG presently operates.]

#53. Transferability: Costs to Operate: Using information provided in #52, please estimate how much additional amount, with respect to normal operating costs, would be required to transfer and then operate this MSG.

TRANSC, 3/74

53-0	TRANSFER COST TO OPERATE:	NA; UNKNOWN	45.5
53-1	TRANSFER COST TO OPERATE:	COST	10.6
53-2	TRANSFER COST TO OPERATE:	COST-COST+10%	12.9
53-3	TRANSFER COST TO OPERATE:	COST+10%-COST+25%	18.2
53-4	TRANSFER COST TO OPERATE:	COST+25%-COST+50%	3.0
53-5	TRANSFER COST TO OPERATE:	COST+50%-COST+100%	6.8
53-6	TRANSFER COST TO OPERATE:	> COST+100%	3.0

	NR	Low	Middle	High	*Certain*
53CL, 3/75	*13.6*	*16.7*	*28.8*	*30.3*	*10.6*

Confidence Level

#54. Obsolescence: Comment on the speed at which you expect this MSG to become obsolescent, indicating the reasons why. We are not referring to the need for reprogramming for new hardware or for minor modifications but to the state where it is no longer sufficiently relevant that either a major modification has to be made or it is completely abandoned. For example, a special simulation may be built and run once for a specific purpose. A simple model may be used for many years, as long as the type of damage calculation it performs is relevant.

#55. Related MSG: Does there exist an MSG that might be regarded as serving approximately the same purpose as yours?

DUPMSG, 3/76

55-0	RELATED MSG:	NO	52.3
55-1	RELATED MSG:	YES	43.9
	NR		3.8

#56. Duplication of Use: If 55-1, i.e. "yes," name the MSG(S) and state why or why not one MSG could serve the purposes of all. If your answer is "no," i.e., 55-0, state why you believe there is no MSG similar to yours.

#57. Clearing House: Is there enough communication in DOD among different gaming and simulation studies or would a clearing house or central agency be of use?

CLEAR, 3/77

*

57-0	CLEARING HOUSE:	HIGHLY USEFUL	14.4
57-1	CLEARING HOUSE:	USEFUL	43.2
57-2	CLEARING HOUSE:	SAME AS IS	23.5
57-3	CLEARING HOUSE:	HARMFUL	8.3
57-4	CLEARING HOUSE:	HIGHLY HARMFUL	5.3
	NR		5.3

Comments on Question #57 are required:

#58. Standardization: After techniques and studies have been in existence for some time, standardization and exchange of common routines is extremely useful. However, sometimes premature attempts to standardize do more harm than good. In particular, redundancy to an outsider may not be redundancy to those doing a study. What is your belief in the advisability of increasing DOD gaming and simulation activity for standardization?

STNRD1, 3/78

*

58-0	STANDARDIZATION:	HIGHLY USEFUL	*6.8*
58-1	STANDARDIZATION:	USEFUL	*24.2*
58-2	STANDARDIZATION:	SAME AS IS	*22.7*
58-3	STANDARDIZATION:	HARMFUL	*31.1*
58-4	STANDARDIZATION:	HIGHLY HARMFUL	*10.6*
	NR		*4.5*

Comments on Question #58 are required:

Low Middle High

Confidence Level

#59. Regional Centers: Models, simulations, and games are operated and built at many locations using many languages and different staffs and equipment. Would, for example, 3-5 appropriately cleared regional centers for most of these activities be a more or less effective way of supporting them? Discuss.

REGCEN, 3/79

HIGHLY USEFUL	*0.8*
USEFUL	*12.9*
SAME	*8.3*
HARMFUL	*46.2*
HIGHLY HARMFUL	*14.4*
NR	*17.4*

#60. External Review Board: Would you comment on reasons both pro and con having an external review board consider this and other MSG's built/operated/used by your organization or activity? Discuss.

EXREV, 3/80

HIGHLY USEFUL	*0.8*
USEFUL	*14.4*
SAME	*15.9*
HARMFUL	*39.4*
HIGHLY HARMFUL	*17.4*
NR	*12.1*

#61. External Review Board, Specification: Would you characterize a "good" external review board as to composition and function? Discuss.

Part II: Model/Simulation/Game Characterization and Description

NOTE: If Part II not filled out by Office of Prime Responsibility and/or user, please indicate who filled out Part II.

Name _____

Organization _____

Relationship to
Prime Office of
Responsibility _____

#62. Scenario Type: #62-0 means that the inputs, outputs, and interpretation of the outputs are all numerical (example: number of targets destroyed). #62-1 means that a verbal description of the scenario must be available prior to use (example: a man-machine or free-form game). #62-2 means that the interpretation of an output is qualitatively modified or interpreted prior to being used (example: a written assessment of qualitative aspects of target damage may accompany a computer output).

SCENTP, 4/7

62-0 SCENARIO TYPE: ONLY NUMERICAL *53.8*
62-1 SCENARIO TYPE: VERBAL DESCRIPTION NEEDED FOR USE *20.5*
62-2 SCENARIO TYPE: VERBAL DESCRIPTION NEEDED FOR ANALYSIS .. *22.7*
NR *3.0*

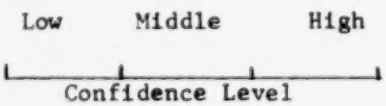
#63. Scenario Description: Rich "realistic" may be used to refer to a scenario which is both rich in detail and purports to be a realistic description of some phenomenon. For example, some tactical games may go to great lengths to have a realistic description of weather conditions, troop morale conditions, terrain conditions, details on buildings, and so forth. The measure of the description of environment should be relative to the real-world phenomenon being modeled. For example, a business game might have fewer details in it than a diplomatic game but be a richer model in relation to actuality than the diplomatic game. Furthermore, some games may have underneath them a mathematical model which is not necessarily apparent to the users. The word "imaginative" can be used to refer to nonfactual modeling where a scenario may contain counterfactual or futuristic features. These aspects may be mixed in with other environmental categorizations.

*63-0 SCENARIO DESCRIPTION: [Describe]

#64. Mathematical Sophistication of MSG: #64-0, None equals less than high school math needed to interpret output or to participate as a player if it is a game. #64-1, Slight equals high school math. #64-2, Moderate equals needs college level math (BA) or engineering degree. #64-3, High equals requires an advanced degree to interpret the output.

MATHS, 4/8

64-0 MATHEMATICAL SOPHISTICATION OF MSG: NONE *0.8*
64-1 MATHEMATICAL SOPHISTICATION OF MSG: SLIGHT *29.5*
64-2 MATHEMATICAL SOPHISTICATION OF MSG: MODERATE *59.1*
64-3 MATHEMATICAL SOPHISTICATION OF MSG: HIGH *8.3*
NR *2.3*



#65. Timing of Moves: Event timing implies that moves depend upon a specific event having occurred. Fixed clock timing implies that there is a certain increment of time upon which model activities are based. There are some models that are both event and fixed clock, in the sense that generally the clock moves forward at regular periods, e.g., descriptions of gross national product in an international model. However, simultaneously there may be moves that depend on specific events, such as conditional checking for threshold effects, time in queues, etc.

MOVES, 4/9

65-0	TIMING OF MOVES: NA; UNKNOWN	21.2
65-1	TIMING OF MOVES: EVENT	39.4
65-2	TIMING OF MOVES: FIXED CLOCK	22.0
	COMBINATION 65-1 and 65-2	15.2
	NR	2.3

#66. Model Time to Real Time Ratio; In describing the ratio of model time to real time one has the problem of distinguishing between the period assigned the real time and the amount of that time which would have been used for the decisionmaking. For example, in a model in which the real time is meant to be quarters, the price decision in a market may only take a week or two to make. In the exercise, twenty minutes may be allotted for the decisionmaking. We now have the problem of deciding whether to scale the twenty minutes against the one week or the three months. We suggest scaling against the allotted real time, i.e., the three months.

MT/RT, 4/10

66-0	MODEL TIME TO REAL TIME RATIO: (Specify)	
	NA-UNKNOWN	25.0
	HIGHLY COMPRESSED	14.4
	COMPRESSED	34.1
	REAL TIME	12.1
	EXPANDED	7.6
	HIGHLY EXPANDED	1.5
	NR	5.3

66CL, 4/11

NR	Low	Middle	High	*Certain*
11.4	*14.4*	*25.8*	*37.1*	*11.4*

Confidence Level

#67. Time Represented: In some instances where the simulator is not necessarily meant to represent any specific structure the time period represented might be interpreted as the present, but it might also be better to describe it as unspecified. In cases of doubt, it is best to note the model in both categories.

TIME, 4/12

67-0	TIME REPRESENTED: PAST	0.0
67-1	TIME REPRESENTED: PRESENT	9.8
67-2	TIME REPRESENTED: FUTURE	18.9
67-3	TIME REPRESENTED: UNSPECIFIED	33.3
67-4	TIME REPRESENTED: NOT RELEVANT	15.9
	COMBINATIONS	18.9
	NR	3.0

#68. Level of Resolution, Model Time: This is the smallest time unit recognized by the game.

LRTIME, 4/13

68-0	LEVEL OF RESOLUTION, MODEL TIME:	NA; UNKNOWN	*18.9*
68-1	LEVEL OF RESOLUTION, MODEL TIME:	SECONDS	*38.6*
68-2	LEVEL OF RESOLUTION, MODEL TIME:	MINUTES	*21.2*
68-3	LEVEL OF RESOLUTION, MODEL TIME:	HOURS	*10.6*
68-4	LEVEL OF RESOLUTION, MODEL TIME:	DAYS	*6.8*
68-5	LEVEL OF RESOLUTION, MODEL TIME:	WEEKS	*0.8*
68-6	LEVEL OF RESOLUTION, MODEL TIME:	QUARTERS	*0.0*
68-7	LEVEL OF RESOLUTION, MODEL TIME:	YEARS	*0.0*
68-8	LEVEL OF RESOLUTION, MODEL TIME:	> YEARS	*0.0*
	NR		*3.0*

Low Middle High

Confidence Level

#69. Level of Resolution, Space: In military games, the spatial level of resolution is frequently important; in most business games spatial level of resolution is at best crude. #69-4 refers to the situation where detail may be supplied for specific locations, but no detail is given between them: for example, details of the terrain around enemy airports, but no details for terrain between them.

LRSPCE, 4/14

69-0	LEVEL OF RESOLUTION, SPACE:	NA	*9.8*
69-1	LEVEL OF RESOLUTION, SPACE:	SMALL AREA (METERS)	*34.8*
69-2	LEVEL OF RESOLUTION, SPACE:	MODERATE (KILOMETERS)	*26.5*
69-3	LEVEL OF RESOLUTION, SPACE:	LARGE (THEATER/CONTINENT) ..	*12.9*
69-4	LEVEL OF RESOLUTION, SPACE:	VARIED	*13.6*
	NR		*2.3*

NR Low Middle High *Certain*

69CL, 4/15 *8.3* | *2.3* | *12.1* | *43.2* | *34.1*

Confidence Level

#70. Level of Resolution, Sides: In some models for some purposes there is no need to resolve the nature of individual teams. Gross performances of the interaction as a whole are being considered regardless of team size. For other purposes the same model may be used with considerable attention paid to the team structure.

Furthermore, a distinction between structured and unstructured groups must be made. In some instances, e.g., when studies of the emergence of leadership are being conducted, it is important that no structure be placed on the teams. In other cases the teams may be given a structure such as that of a corporation or a military command.

#70-7. As platoon, division, air force, etc., vary in size between the services, name the generic term for the unit.

LRSIDE, 4/16

70-0	LEVEL OF RESOLUTION, SIDES:	NA	*30.3*
70-1	LEVEL OF RESOLUTION, SIDES:	INDIVIDUALS	*23.5*
70-2	LEVEL OF RESOLUTION, SIDES:	SMALL GROUPS (STRUCTURED)	*19.7*
70-3	LEVEL OF RESOLUTION, SIDES:	ORGANIZATIONS, SMALL (< 100)	*13.6*
70-4	LEVEL OF RESOLUTION, SIDES:	ORGS., LARGE (> 1000)	*4.5*
70-5	LEVEL OF RESOLUTION, SIDES:	ORGS., VERY LARGE	*3.0*
70-6	LEVEL OF RESOLUTION, SIDES:	SMALL GROUPS, UNSTRUCTURED	*0.0*
70-7	LEVEL OF RESOLUTION, SIDES:	NAME UNIT ( )	*3.0*
	NR		*2.3*

Comment:

Low Middle High

Confidence Level

#71. Level of Resolution, Military Action: The categories here are arranged in order of progressive generality, thus #71-5 includes war as a part of ongoing diplomacy.

LRMIL, 4/17

71-0	LEVEL OF RESOLUTION, MILITARY ACTION:	NA; UNKNOWN	*19.7*
71-1	LEVEL OF RESOLUTION, MILITARY ACTION:	ENGAGEMENT	*44.7*
71-2	LEVEL OF RESOLUTION, MILITARY ACTION:	BATTLE	*10.6*
71-3	LEVEL OF RESOLUTION, MILITARY ACTION:	CAMPAIGN	*11.4*
71-4	LEVEL OF RESOLUTION, MILITARY ACTION:	WAR	*13.6*
71-5	LEVEL OF RESOLUTION, MILITARY ACTION:	DIPLOMATIC	*0.0*

Comment: [Note specific details of this MSG.]

NR Low Middle High *Certain*

71CL, 4/18 *6.8* | *3.8* | *13.6* | *48.5* | *27.3*

Confidence Level

#72. Random Events: It is possible to use a model occasionally with random events and on other occasions without random events. In this case both categories should be checked. One should not regard this question as a binary choice; both are possible.

RNDM, 4/19

72-0	RANDOM EVENTS:	NO	*46.2*
72-1	RANDOM EVENTS:	YES	*52.3*
	NR		*1.5*

Comment: [Note specific details of this MSG.]

CHARACTERIZATION: PLANNING FACTORS AND DATA

#73. Data Sources and Validity: Where did the data for this MSG come from? List sources in as complete a fashion as possible. Were any independent checks performed to insure the accuracy, timeliness, consistency, and overall quality of the data? Describe them.

DATAS, 4/20

*73-0 DATA SOURCES AND VALIDITY: [Comments]

NA; UNKNOWN	*3.5*
MILITARY; NO CROSS CHECK	*30.3*
MILITARY; CROSS CHECK	*29.5*
CIVIL	*1.5*
GENERATED OWN	*2.3*
FIELD EXERCISE	*1.5*
COMBINATIONS	*25.0*
NR	*6.1*

#74. Types of Data: It has been suggested that three types of data can be distinguished in games and simulations:

Type 1 data = High certainty data
Examples: range of a weapon under specified conditions, the size of a unit of troops, etc.

Type 2 data = Certain level of uncertainty
Examples: outcome of a company fight, radar detection range (these need parametric studies and sensitivity analysis for validation).

Type 3 data = High uncertain and hard to test
Examples: diplomatic behavior, enemy goals, broad social or economic reactions to policy.

*74-0 TYPES OF DATA
[In terms of the three types of data requirements describe the data needed for your game or simulation.]

#75. Number of Inputs (Constants, Parameters, and Variables) in MSG: This may vary from use to use; therefore, if necessary, give lower bound, average, and upper bound.

75-0 NUMBER OF INPUT CONSTANTS: (Specify)
75-1 NUMBER OF INPUT PARAMETERS: (Specify)
75-2 NUMBER OF INPUT VARIABLES: (Specify)

Comment:

Low Middle High

Confidence Level

#76. Number of Output Variables in MSG: This may vary from use to use; therefore, if necessary, give lower bound, average, and upper bound.

76-0 NUMBER OF OUTPUT VARIABLES: (Specify)

Low Middle High
Confidence Level

Comment:

#77. Intangibles: Are sometimes ruled out by limiting the scope of the study; by obtaining rulings from higher authority as to how they are to be treated; by using expert estimates; by using high and low bounding procedures or by other methods.

*77-0 INTANGIBLES
[Describe how intangibles are treated in this MSG. In answering give a for instance.]

#78. Sensitivity Analysis: Discuss the importance of sensitivity analysis for this MSG and describe how it is done, if it is done at all. We are not interested in sensitivity analysis done as a routine matter of debugging; rather, what has been done since the MSG has been operational?

SENSET, 4/21
78-0 SENSITIVITY ANALYSIS PERFORMED?: NO *44.7*
YES *46.2*
NR *9.1*

Comment:

*79-0 DATA COLLECTION TIME: (_____)
[Estimate (in man-years) data collection time required.]

Low Middle High
Confidence Level

#80. Data Validation: Frequently all data come from another agency or source with no checks from the user groups. Sometimes a user group obtains its information first hand by measurement, observation, field tests, etc. Describe how you get your data inputs and what independent checks or procedures you perform to challenge the validity of the data.

DATAV, 4/22

*80-0 DATA VALIDATION:

NA; UNKNOWN	*6.8*
HIGH QUALITY	*13.6*
MODERATE	*28.0*
WEAK	*29.5*
NOT DONE	*15.9*
NR	*6.1*

MODEL OPERATION: SUPPORTING FACILITIES

#81. Computer Used for Running a Simulation: We mean the different computers for which this model has been run. In some cases there may be only one, and in other cases many modifications may have been issued for different machines. List not more than the three most frequently used operating systems.

81-0 COMPUTER USED FOR RUNNING: NA
81-1 COMPUTER(S) USED FOR RUNNING: THREE OR LESS (Specify)

Low Middle High
Confidence Level

#82. Program Language: This calls for the language in which the simulation has been programmed. Frequently there may be a series of languages. All should be noted.

LANG, 4/23

82-0 PROGRAM LANGUAGE: NA
82-1 PROGRAM LANGUAGE(S): (Specify)

NA	*1.5*
FORTRAN	*79.5*
PL-1	*1.5*
COBOL	*0.8*
GPSS	*3.0*
SIMSCRIPT	*3.8*
ASSEMBLER	*3.0*
Other	*2.3*
NR	*4.5*

	NR	Low	Middle	High	*Certain*
82CL, 4/24	*5.3*	*0.8*	*6.8*	*44.7*	*42.4*

Confidence Level

#83. Program Size: Approximately how many instructions are there in the language(s) noted above?

MSGSIZ

83-0 PROGRAM SIZE: (Specify language)
83-1 PROGRAM SIZE: (Specify language)

NA; unknown	*6.1*
< 1000 instructions	*8.3*
1-2K	*9.8*
2-4K	*15.9*
4-6K	*9.8*
6-8K	*7.6*
8-10K	*3.0*
> 10K	*27.3*
NR	*12.1*

#84. Facilities: #84-4 This refers to the situation where a special system set of languages or program may have been written to accompany the running and general handling of a specific model. For example, some models depend upon the availability of much of the specialized extra hardware and software. Although it is possible that the models themselves can travel, much of their power is lost when the accompanying personnel and equipment are not available.

FACIL, 4/26

84-0	FACILITIES: NA; UNKNOWN	*65.2*
84-1	FACILITIES: SPECIAL BUILDING OR INSTITUTION	*2.3*
84-2	FACILITIES: DEDICATED COMPUTER (UNCLASSIFIED)	*6.8*
84-3	FACILITIES: DEDICATED COMPUTER/CLASSIFIED TAPES	*9.8*
84-4	FACILITIES: SPECIAL LANGUAGE, LIBRARY OR COMPUTATIONAL SYSTEM	*12.9*
	NR	*3.0*

Low Middle High

Confidence Level

SIMULATION/STUDY/MODEL PRODUCTION COSTS

General caveat on building costs. The possibilities for obtaining close cost estimates for many MSGs are difficult in the extreme. This is not merely a problem of gathering information; it is a problem of correct conceptualization of the costs that should be imputed to certain forms of work. In particular, joint costs play an enormously important role; thus it is not an easy matter to impute costs for items such as computer time, joint use of educational facilities, and so forth. In this coding scheme we wish to stress that the costing figures presented should be used with extreme caution.

#85. Development Time is a concept about which it is difficult to be both precise and accurate. For our purposes, we must emphasize that the categories indicated are crude in the extreme. We are trying to indicate the elapsed time between the decision to build a particular model and the first production run of that model. In many cases after a model has been used once, development goes on for many years. Thus our criterion may be regarded as presenting a gross underestimation of development time. Furthermore, additional complications appear on occasion as a model develops and it may change its name. A further clarification of this idea, according to our meaning, is the time from the inception of the work on construction until the first production run. This is contrasted with a debugging run; they are not the same. We specifically do not consider further modification after the first production run has taken place, even though *ex post facto*, the first production run is then regarded as "experimental."

DEVTM2, 4/28

*85-0 DEVELOPMENT TIME: (_____)

< 3 months	*3.8*
3-6 months	*22.0*
7-12 months	*25.8*
13-18 months	*9.8*
19-24 months	*8.3*
25-30 months	*3.8*
31-36 months	*3.0*
37-42 months	*3.0*
> 42 months	*5.3*
NR	*15.2*

85CL, 4/29

NR	Low	Middle	High	*Certain*
12.1	*8.3*	*29.5*	*40.2*	*9.8*

Confidence Level

#86. We contrast total man-years with professional man-years. Under category #86 we include graduate students, secretarial help, programming assistance and any other forms of voluntary contribution of time. These are direct man-years and do not include allocation of institutional administrative overhead.

DEVMY1, 4/30

*86-0 DEVELOPMENT TIME: TOTAL MAN-YEARS: (_____)

NA; unknown	*12.9*
0-1 man-years	*21.2*
2-5 man-years	*31.8*
6-10 man-years	*9.8*
11-20 man-years	*8.3*
> 20 man-years	*6.1*
NR	*9.8*

86CL, 4/31

NR	Low	Middle	High	*Certain*
18.9	*11.4*	*41.7*	*22.0*	*6.1*

Confidence Level

#87. Professional man-years used in the development of a model. Under this category we include both professional designers and consultants. In many cases there are also graduate students, additional helpers, ordinary programming assistance, as well as an enormous amount of office staff.

DVPMY1, 4/32

87-0 DEVELOPMENT TIME: PROFESSIONAL MAN-YEARS: (_____)

NA; unknown	*12.1*
0-1 man-years	*25.8*
2-5 man-years	*32.6*
6-10 man-years	*9.8*
11-20 man-years	*6.8*
> 20 man-years	*2.3*
NR	*10.6*

#88. Development Team Professional Profile: Describe the professional makeup of the development team (including consultants).

*88-0 DEVELOPMENT TEAM PROFESSIONAL PROFILE: (Describe)

88CL, 4/33

NR	Low	Middle	High	*Certain*
23.5	*6.8*	*20.5*	*37.1*	*12.1*

Confidence Level

DVPRG1, 4/34

89-0 DEVELOPMENT TIME: PROGRAMMER MAN-YEARS (_____)

NA; unknown	*19.7*
0-1 man-years	*37.1*
2-5 man-years	*24.2*
6-10 man-years	*4.5*
11-20 man-years	*3.0*
> 20 man-years	*1.5*
NR	*9.8*

MODEL CHARACTERIZATION: DOCUMENTATION

#90. Documentation: #90-1 Excellent means that the documentation is sufficiently good that it can be picked up elsewhere by a different group of people and operated without or with a minimum of long-distance telephone calls and conferences. #90-3 Average means that the documentation exists in some form but it is moderately hard to operate without at least some discussions with the originators of the document. #90-6 Uneven/highly variable is put in to characterize simulation in which there is spotty documentation, often indicating an evolution of different programmers and different groups working on the model. To get decent documentation one may have to search among the disarray of documents that are presented.

DOCEXT, 4/35

* 90-0	DOCUMENTATION, EXTENT:	NA; ZERO; UNKNOWN	*2.3*
90-1	DOCUMENTATION, EXTENT:	EXCELLENT	*15.9*
90-2	DOCUMENTATION, EXTENT:	VERY GOOD	*26.5*
90-3	DOCUMENTATION, EXTENT:	AVERAGE	*32.6*
90-4	DOCUMENTATION, EXTENT:	WEAK	*8.3*
90-5	DOCUMENTATION, EXTENT:	POOR	*1.5*
90-6	DOCUMENTATION, EXTENT:	UNEVEN/HIGHLY VARIABLE	*3.8*
90-7	DOCUMENTATION, EXTENT:	UNAVAILABLE	*6.1*
	Other Combinations	.....	*0.8*
	NR	.....	*2.3*

#91. Documentation Availability/Location: 91-5. Proprietary (classified)/write author. What we mean here is that the information on the simulation is classified in the sense of top secret, secret, and so on. To obtain this information, it is necessary to write the author. This relieves the burden of identifying the document and approving of its transmittal to the author and to the people who are searching for the document. Problems of clearance, need to know, and so on can then be resolved between the two interested parties.

DOCLOC1, 4/36-38

91-0	DOCUMENTATION, AVAIL./LOC.:	NA; UNKNOWN	*9.8*
91-1	DOCUMENTATION, AVAIL./LOC.:	OUT OF PRINT/UNKNOWN	*6.1*
91-2	DOCUMENTATION, AVAIL./LOC.:	PROPRIETARY/NOT FOR PROFITS	*4.5*
91-3	DOCUMENTATION, AVAIL./LOC.:	PROPRIETARY/COMMERCIAL	*0.0*
91-4	DOCUMENTATION, AVAIL./LOC.:	PROPRIETARY/WRITE AUTHOR ...	*10.6*
91-5	DOCUMENTATION, AVAIL./LOC.:	PROPRIETARY (CLASSIFIED)/ WRITE AUTHOR	*16.7*
91-6	DOCUMENTATION, AVAIL./LOC.:	PUBLIC/DEFENSE DOCUMENTATION CENTER	*47.0*
91-7	DOCUMENTATION, AVAIL./LOC.:	PUBLIC/LIBRARY OF CONGRESS .	*0.0*
91-8	DOCUMENTATION, AVAIL./LOC.:	PUBLIC/PROFESSIONAL JOURNALS, BOOKS	*0.8*
	NR	.....	*4.5*

* 92-0	DOCUMENTATION:	GENERAL OVERVIEW (Describe)

#93. Publication Type: #93-3. Reports/analyses, etc. This refers to publications, possibly generated after a series of runs, to be used as an official document, as a report to a higher authority, or possibly as even a supporting argument for a request for funds. This is in distinction to a document which is a book or article for nonspecific purposes.

DOCPUB, 4/39

93-0	PUBLICATION TYPE:	BOOKS OR ARTICLES	*1.5*
93-1	PUBLICATION TYPE:	USER MANUALS	*13.6*
93-2	PUBLICATION TYPE:	PROGRAM DECKS/LISTINGS	*3.8*
93-3	PUBLICATION TYPE:	REPORTS/ANALYSES, ETC.	*24.2*
	93-0 and 93-1	.....	*1.5*
	93-1 and 93-2	.....	*20.5*
	Other combinations	.....	*25.8*
	NR	.....	*9.1*

*94-0 PUBLICATION OR DOCUMENT IDENTIFICATION:
[Specify one or two documents most relevant to this game simulation or study. Give full references so that documentation may be assembled.]

TECHNICAL COORDINATION AND STANDARDS

#95. Technical Coordination: One might have a central clearing house which performs a clerical operation with no professional or evaluative role. One might otherwise have a staff of several permanent professionals whose task is to compose and to technically describe the inventory of models, simulation, or games. In your opinion, supposing that a central clearing house exists, should it have a technical staff? Discuss.

TECH, 4/40

95-0	TECHNICAL COORDINATION: HIGHLY UNDESIRABLE	*12.9*
95-1	TECHNICAL COORDINATION: UNDESIRABLE	*13.6*
95-2	TECHNICAL COORDINATION: INDIFFERENT	*21.2*
95-3	TECHNICAL COORDINATION: DESIRABLE	*22.7*
95-4	TECHNICAL COORDINATION: HIGHLY DESIRABLE	*22.0*
	NR	*7.6*

#96. Standards Committee: Question 58 asked about the desirability of standardization without specifying what. Is it premature to try to form a professional standards committee for models, games, and simulations. Is it needed? Would it probably do good or harm? Please Comment.

STNRD2, 4/41

HIGHLY USEFUL	*0.0*
USEFUL	*14.4*
SAME	*9.1*
HARMFUL	*41.7*
HIGHLY HARMFUL	*20.5*
NR	*14.4*

#97. Questionnaire Evaluation [Written comments are also welcome.]

QUEVAL, 4/42

97-0	RESPONDENT'S EVALUATION OF QUESTIONNAIRE: EXCELLENT	*2.3*
97-1	RESPONDENT'S EVALUATION OF QUESTIONNAIRE: GOOD	*20.5*
97-2	RESPONDENT'S EVALUATION OF QUESTIONNAIRE: MODAL	*25.8*
97-3	RESPONDENT'S EVALUATION OF QUESTIONNAIRE: POOR	*24.2*
97-4	RESPONDENT'S EVALUATION OF QUESTIONNAIRE: BAD	*12.9*
	NR	*14.4*

Researchers' evaluation of the quality of the questionnaire responses:

IQC, 4/43

EXCELLENT	*2.3*
GOOD	*19.7*
MODAL	*32.6*
POOR	*30.3*
BAD	*15.2*

Part III: Man-Machine Games or Simulations and Manual Games

CHARACTERIZATION: GENERAL DESCRIPTION

#98. Control Team: By the phrase "control team" we mean a formal team as part of the game making up rules or interacting with the other teams as the game progresses (#98-3). This should be contrasted with game management control (#98-2), where the directors or the managers or referees do not play a direct, important, game-influencing role. For example, most business games under this categorization do not have a control team. Few two-sided dueling games have control teams. Almost all political-military exercises have control teams.

98-0 CONTROL TEAM:UNKNOWN
98-1 CONTROL TEAM:NO
98-2 CONTROL TEAM:YES, BUT COULD BE COMPUTERIZED
98-3 CONTROL TEAM:YES, MUST BE USED

Low Middle High

Confidence Level

#99. Number of Live Player Teams: This excludes a control team. If the game has been designed to have a variable number of teams, this should be noted. The number of live teams actually used in different runs should also be indicated.

99-0 NUMBER OF LIVE PLAYER TEAMS: (_____) Specify

#100. Number of Robots: The same observations hold for robots or completely computerized teams. In simulations where a combat system is being simulated, such as in a totally computerized duel, we may regard the model as having two robots, one for each side playing the other. A simple test for this classification would be to ask how to convert this game into a man-machine game. In order to do so, some of the automated decisionmaking of one or both sides would be removed and replaced by live player decisions.

100-0 NUMBER OF ROBOT TEAMS: (_____) Specify

#101. Sequencing of Moves: There are some games (such as many of the war games) played where moves are simultaneous. Furthermore, many games, such as two-person matrix experiments, usually utilize simultaneous moves. There are other games in which the moves are in fixed sequential order; examples of such are chess or checkers. There are other games in which the moves are in variable order; frequently either chance will determine the next move or a player is in a position to give the move to another player. Craps is an example of just such a game; depending on how one defines chess, one pauses to see who selects sides at the beginning in the first move in an invariable order, after which it is in fixed sequential order. Another set of examples is sporting events. In baseball the batting order is fixed. In football, the interteam play goes in no particular order although a series of downs is in fixed format.

In some games some of the moves may be simultaneous, whereas others may be in variable order. For example, in some strategic war games it may be required to pay costs for force maintenance every period. However, when new weapons sytems investment considerations are included, it is up to the individual team to decide whether or not they intend to invest.

101-0 SEQUENCING OF MOVES: UNKNOWN
101-1 SEQUENCING OF MOVES: SIMULTANEOUS
101-2 SEQUENCING OF MOVES: FIXED SEQUENTIAL
101-3 SEQUENCING OF MOVES: VARIABLE ORDER

Low Middle High

Confidence Level

#102. Moves per Team: In this case, for complex games, we are referring to a move by the team as a whole, not to the many individual small transactions that might be taking place.

There are some games, such as damage-exchange rate and attrition evaluation games or continuous search games, in which the simulation or the computation is basically a mathematical procedure with no clear definition of move. In this instance we classify the move description 102-0.

102-0 MOVES PER TEAM: NA;UNKNOWN
102-1 MOVES PER TEAM: MOVES PER TEAM (_____) Specify

#103. Complementary Procedures: #103-2 includes lectures; #103-4 includes mathematical solutions such as game-theoretic solutions; and #103-6 includes field exercises.

103-0 COMPLEMENTARY PROCEDURES: NA;UNKNOWN
103-1 COMPLEMENTARY PROCEDURES: NONE
103-2 COMPLEMENTARY PROCEDURES: LECTURES
103-3 COMPLEMENTARY PROCEDURES: CASE STUDIES/HISTORY
103-4 COMPLEMENTARY PROCEDURES: SIMULATION/ANALYSIS
103-5 COMPLEMENTARY PROCEDURES: "EXPERIENCE"
103-6 COMPLEMENTARY PROCEDURES: FIELD EXERCISE

Low Middle High
Confidence Level

104-0 FORMAL GAME TYPE: NA;UNKNOWN
104-1 FORMAL GAME TYPE: UNDEFINED, PAYOFFS NOT SPECIFIED
104-2 FORMAL GAME TYPE: CONSTANT SUM GAME
104-3 FORMAL GAME TYPE: NON-CONSTANT SUM GAME
104-4 FORMAL GAME TYPE: ONE-PERSON MODEL (MAXIMIZATION)

Low Middle High
Confidence Level

#105. Rules: #105-1 Rigid manual. An example of a rigid manual game would be chess. All of the rules are well specified in advance and the game is a manual game. #105-2 Semi-rigid manual. An example would be a war game, where, although the fire power and other planning factors are supplied, some questions during the game may be addressed to a referring board and certain rules or rulings are made during the course of play. #105-3 Free-form or referee's direction would be a game such as a political military exercise in which the control teams and the referee's direction are critical to conducting the game. The melding of the moves and adjudication of attempted moves is a critical feature of such a game. #105-4 Rigid computerized rules are distinguished from rigid manual inasmuch as in general the rules of manual games are much more visible and hence much more open to questioning than are those of computerized games. One of the major dangers of using computerized games is that a great amount of bad modeling and theorizing can be hidden in computer programs. #105-5 Semi-rigid rules computerized. In this case the game may be computerized, but not all of the rules are necessarily described. For example, one might have a business or marketing game in which although virtually everything to do with sales, manufacturing, and internal running of the firm has been computerized, press releases and newspapers are issued to the firm, thus adding a verbal and somewhat less formalized component to the game. #105-6 In some instances games or simulations are nothing more than the dynamics of the behavior of a formal mathematical model or computer program. The category also includes rules that are well defined in a game-theoretic sense.

In some games, although all rules are given they are so complicated that no single individual will know all of them (#105-7). In other games part of the purpose is to discover unstated rules (#105-8). In free-form games, there may be considerable uncertainty concerning basic structure (#105-9).

105-0 RULES: NA;UNKNOWN
105-1 RULES: RIGID MANUAL
105-2 RULES: SEMI-RIGID MANUAL
105-3 RULES: FREE FORM/REFEREE'S DIRECTION
105-4 RULES: RIGID COMPUTERIZED
105-5 RULES: SEMI-RIGID COMPUTERIZED
105-6 RULES: PROGRAM OR FORMAL MATH MODEL
105-7 RULES: WELL DEFINED BUT TOO LARGE FOR COMPREHENSION
105-8 RULES: SOME RULES, NOT KNOWN
105-9 RULES: UNCERTAINTY CONCERNING BASIC STRUCTURE

Low Middle High
Confidence Level

#106. Structure of Game: In the category structure of games we include, under #106-3 matrix game, a game which could conceivably be approximated by a matrix even though in some cases the strategies may be continuous. For example, it may be permitted to have a player pick any price he wants in the range from $0 - $100, but in general he may be limited to bids in units of a dollar. Even if he wanted to make it a continuous game, it is quite possible that the machine would round it off by a finite approximation and thereby make it a matrix game.

Some games may fit into more than one category. For example, a business game may have a formal structure such as an iterated matrix game; however, it begins play with a scenario describing the state of the market. #106-2 Explicit mathematical 2 x 2 matrix games. #106-3 Other matrix game. Here we are referring to a purely abstract mathematical structure provided as the venue for the game. #106-4 Implicit computerized damage-exchange calculation which in fact can be regarded as a computation on an enormously large matrix. #106-5 Iterated matrix game. In many instances, such as many plays with the Prisoner's Dilemma, the game is played in a dynamic mode. However, a great amount of the decisionmaking is performed on the same structure period after period. Many business games have the same "battlefield" of a more or less similar market each period. #106-6 Free form extensive. Games like political military exercises would fall in this category. They are played move by move, but they are not necessarily repeating the same situation on each move. #106-7 Formal extensive. A game such as chess is played in formal extensive manner. The rules are rigid and well-defined; however, the players move play by play and do not enunciate overall strategies for this game. The remaining two categories concern games in characteristic function form or games in which the prime area of investigation is coalitions. #106-8 Free form characteristic function. Such a game would be one devoted to studying the coalition possibilities for a treaty on the use of the Danube, as just one example. #106-9 Formal characteristics function form. There have been experiments done using games specified in characteristic function form where the experimenter studies how the players divide the money they receive from cooperative acts.

Question #106 calls for some familiarity with several concepts of game theory. If you are not sufficiently familiar with the terms to answer, check #106-11 and proceed to the next question.

106-0 STRUCTURE OF GAME: UNKNOWN/NA
106-1 STRUCTURE OF GAME: SCENARIO/VERBAL DESCRIPTION
106-2 STRUCTURE OF GAME: 2 X 2 MATRIX
106-3 STRUCTURE OF GAME: OTHER MATRIX
106-4 STRUCTURE OF GAME: IMPLICIT MATRIX
106-5 STRUCTURE OF GAME: ITERATED MATRIX
106-6 STRUCTURE OF GAME: "FREE FORM EXTENSIVE"
106-7 STRUCTURE OF GAME: FORMAL EXTENSIVE
106-8 STRUCTURE OF GAME: "FREE FORM" CHARACTERISTIC
106-9 STRUCTURE OF GAME: FORMAL CHARACTERISTIC FUNCTION
106-10 STRUCTURE OF GAME: PURE MATH MODEL: SIMULATED OR ANALYZED
106-11 STRUCTURE OF GAME: QUESTION NOT CLEAR

Low Middle High

Confidence Level

#107. Information State: #107-1 and #107-2. The first refers to perfect information in the game-theoretic sense: all players know all that can be known at all times. An example of a game with perfect information is a chess game. Incomplete information is the situation that prevails in a poker game. The kibitzers or a referee may know what the hands of all the players look like, but the players do not know each other's hands. #107-5 Considerable structural uncertainty refers to games in which the rules and the general environment are by no means clear at the beginning of the game. An example would be an extremely free form political game to be played in a future time period with the skimpiest of scenarios available. #107-3, #107-6 In some games that are designed to teach procedures and approaches to a problem, it is worth distinguishing information states in which information can be bought as contrasted with those in which calculation can be bought. For example, in a business game one may have information concerning the reaction of the market to various arrays of prices. On the other hand, one may not have procedures for fitting models to this information. The procedures such as least-square statistical packages can be regarded as calculation packages. In some cases these may be available to players from "consultants" who charge for their use.

107-0 INFORMATION STATE: NA; UNKNOWN
107-1 INFORMATION STATE: PERFECT
107-2 INFORMATION STATE: INCOMPLETE
107-3 INFORMATION STATE: INFORMATION CAN BE BOUGHT
107-4 INFORMATION STATE: SOME RULES NOT KNOWN/MIXED
107-5 INFORMATION STATE: CONSIDERABLE STRUCTURAL UNCERTAINTY
107-6 INFORMATION STATE: CALCULATION CAN BE BOUGHT

Low Middle High
Confidence Level

#108. Computer Use: Under #108-1 bookkeeping/light staff work, we include the use of the computer for somewhat more than straight bookkeeping, but somewhat less than one might wish to describe as heavy analysis. #108-6 Man-machine on-line interrogative mode. We distinguish this from man-machine interactive in the sense that interactive merely implies that the machine does the computations on the environment, whereas interrogative implies that in the process of calculating, the machine questions the player and obtains answers from the player.

108-0 COMPUTER USE: NONE/BOARD/FIELD, ETC.
108-1 COMPUTER USE: BOOKKEEPING/LIGHT STAFF WORK
108-2 COMPUTER USE: ANALYTICAL AID TO PLAY
108-3 COMPUTER USE: ANALYTICAL AID DEBRIEFING/POST GAME ANALYSIS
108-4 COMPUTER USE: ANALOGUE
108-5 COMPUTER USE: MAN-MACHINE INTERACTIVE
108-6 COMPUTER USE: MAN-MACHINE ON-LINE (INTERROGATIVE MODE)
108-7 COMPUTER USE: OTHER (Specify)

Low Middle High
Confidence Level

#109 Gaming Facilities: #109-7 This refers to the situation where a special system set of languages or program may have been written to accompany the running and general handling of a specific game. For example, some games run at the labs at Berkeley and some games run with the TRACE system at SDC or at UCLA depend upon the availability of much of the specialized extra hardware and software. Although it is possible that the games themselves can travel, much of their power is lost when the accompanying programs and equipment are not available.

109-0 GAMING FACILITIES: NA; UNKNOWN
109-1 GAMING FACILITIES: SPECIAL BUILDING OR INSTITUTION
109-2 GAMING FACILITIES: SPECIAL LAB
109-3 GAMING FACILITIES: DEDICATED COMPUTER
109-4 GAMING FACILITIES: RENTED LAB
109-5 GAMING FACILITIES: RENTED "SPACE"
109-6 GAMING FACILITIES: TEMPORARY "FREE SPACE"; INFORMAL
109-7 GAMING FACILITIES: SPECIAL LANGUAGE, LIBRARY OR COMPUTATIONAL SYSTEM

Low Middle High
Confidence Level

GAME OPERATION TIME FRAME

110-0 SET-UP TIME (_____) Specify

#111. Elapsed time of run, start to finish: We refer to the playing time of a single game or, in the case of experimental games, of a single experiment which could involve several replications; for example, when a series of experiments is run sequentially over several days. In some instances the nature of the game and its format make this figure quite precise. In other cases there is a variability of several orders of magnitude concerning how long the game takes to play. For example, some business games are run on the basis of one decision a day or one decision a week that is made in less than an hour; otherwise, the individuals carry on their normal routines.

Under this category we refer to total elapsed time from the start of the game to the debriefing. In some informal instances, such as running a game with a class, one may run the game for the whole of a semester. For example, the Carnegie Tech game may run for a period of seven or eight months. The games of the Studies, Analysis and Gaming Agency are frequently run in two different modes; One is a 3-1/2 day intensive game, and the other stretches over several weeks. In the case of experimental games, games are often run in parallel -- possibly intensively during one evening for the whole of a game, but in some cases batches of games are run comprising an experiment. In other cases players may run for more than one day. If a game is run on more than one mode, the different elapsed times should be indicated.

111-0 ELAPSED TIME OF RUN, START TO FINISH:

Low Middle High
Confidence Level

#112. Player Game Play Time: By this we mean the amount of time spent in actually playing a game. This includes briefing, decisionmaking, and debriefing associated with the game.

112-0 PLAYER GAME PLAY TIME: NA;UNKNOWN
112-1 PLAYER GAME PLAY TIME: <3 HOURS
112-2 PLAYER GAME PLAY TIME: >3-6 HOURS
112-3 PLAYER GAME PLAY TIME: >6-12 HOURS
112-4 PLAYER GAME PLAY TIME: >12-24 HOURS
112-5 PLAYER GAME PLAY TIME: >1-7 DAYS
112-6 PLAYER GAME PLAY TIME: >1 WEEK (_____) [Specify]

Low Middle High

Confidence Level

#113. Formal Game Prebriefing Procedure: We note that the military uses the word "indoctrination" when describing materials sent out prior to the formal briefing time in a game.

The distinction to be made here concerns whether or not a game has a formal prebriefing procedure or whether the prebriefing is informal or nonexistent. For example, chess players in general need no prebriefing if they already know the rules. Some simple games, such as experiments with 2 x 2 matrix games, may be run with an informal briefing from the experimenter who has either decided to dispense with formal control or has overlooked the use of formal control in the verbal description of the game.

113-0 FORMAL GAME PREBRIEFING PROCEDURE: NA;UNKNOWN
113-1 FORMAL GAME PREBRIEFING PROCEDURE: NO
113-2 FORMAL GAME PREBRIEFING PROCEDURE: YES

Low Middle High

Confidence Level

#114. Formal Briefing Time (%): This can be described as a percentage of player game-play time. For example, if it takes a player ten hours to play a game and there is a briefing session of 1/2 an hour, this means that briefing time is five percent of game play time.

114-0 FORMAL BRIEFING TIME (%): (_____) [Specify]

Low Middle High

Confidence Level

#115. Debriefing Time: This is also stated as a percentage of game play time for the player. In general, many experimental games, and certainly games for entertainment, have little if any debriefing. Occasionally there are post mortems after chess. Operational games and games for teaching and training may have considerable debriefing. For operational use, the length of debriefing is fairly clear; for example, after a SAGA game, there may be a half day set aside (beyond the three days of play) specifically for discussion and formal debriefing. However, with a game used for teaching purposes, such as the Carnegie Tech game, one might regard the complete course taken with the game as a briefing-debriefing session; in that case, one could claim that the debriefing and briefing time could easily be as large if not larger than the game-playing time.

If a game is used for different purposes one should indicate the briefing and debriefing time of each. The context of purposes stated in the earlier question should make clear the specific category to which a game belongs.

115-0 DEBRIEFING TIME (%): >25 (_____) [Specify]

Low Middle High

Confidence Level

#116. Control Time, Total Expenditure: This includes briefing time, running time, and debriefing time of the control group. For example, in a SAGA exercise, there may be field trips and so forth before the game's scenario can be written. This type of work would be classified under game construction. The time we are interested in here is that amount spent by the individuals composing the control team for running purposes. If it is necessary for members of the control team to be briefed or indoctrinated for several weeks in advance, this would be counted as part of control time. If, however, as is usually the case, they join the group merely a day or two or even less before play time, we would start to count control team time from this point. In some instances there is not a formal control team; however, there is nevertheless a game director -- formal or informal -- whose time is being used to supervise the process. This should also be counted even though this will generally amount to no more than a few hours or a few days.

116-0 CONTROL TIME, TOTAL EXPENDITURE: MAN-WEEKS (_____)
[Specify]

Low Middle High

Confidence Level

#117. Post Debriefing Analysis (Intensity): This refers to the analysis of the game run after the game is over; the debriefing may have taken place. In other words, this should not be confused with debriefing. It refers to the analysis which may be done by researchers, possibly the players in a different mode, or others to determine what has been learned from the game. In the case of experiments, this is quite obviously where much of the work is concentrated. In the case of operational games, this is where much of the work should be concentrated if one wishes to measure the effectiveness of the exercise. #117-0 Post debriefing analysis. For straight simulations there is no debriefing, hence this category is not applicable. At the same time simulations invariably involve analysis after they are run; this is picked up in #118. #117-4, Considerable, would apply where the analysis time may be even more than the game-playing time.

117-0 POST DEBRIEFING ANALYSIS (INTENSITY): NA;UNKNOWN
117-1 POST DEBRIEFING ANALYSIS (INTENSITY): NONE
117-2 POST DEBRIEFING ANALYSIS (INTENSITY): SLIGHT
117-3 POST DEBRIEFING ANALYSIS (INTENSITY): MODERATE
117-4 POST DEBRIEFING ANALYSIS (INTENSITY): CONSIDERABLE

Low Middle High

Confidence Level

#118. Analysis Time: Answer this question in terms of man-weeks, or the percentage of actual time spent by individuals involved in the analysis as compared with total game play time. There may be an enormous amount of automated analysis going on with a small expenditure of human time. This question is concerned with the human time.

118-0 ANALYSIS TIME: (_____) [Specify]

119-0 SET UP COSTS AS % OF TOTAL COSTS TO OPERATE: (_____)
[Specify]

Low Middle High

Confidence Level

#120. Cost to Operate at New Location: Except for going to the new location we assume that costs will be distributed the same way. In other words, if one is calculating on free secretarial help at one place, one calculates some free secretarial help at the other place.

It makes a great difference whether or not you can bring in an operating crew. However this means that cost to operate should be looked at as the minimum cost to bring in an operating crew or cost to train new people on location. If no crew is available, it may be either impossible to transfer the game or inordinately expensive.

When we refer to new location we assume that the new location has hardware that is suited for the game involved.

120-0 COST TO OPERATE AT NEW LOCATION: (_____) [Specify]

Low Middle High

Confidence Level

GAME CHARACTERIZATION: PLAYERS

#121. Player Selection. #121-5 "Proprietary interest advocates" refers to the use of players who have a personal interest in the actual use of the game or in the use of the results of the game for some specific purpose. For example, a proprietary interest advocate might be a group of individuals either advocating or opposing a weapons system, such as MIRV, or the SST, or a specific piece of hardware. The game may be used as part of an ongoing advocacy process. In cases such as this, it is extremely important to sort out players whose play surrounds the environment of the game from players whose interests cease with the use of the game for whatever its explicit, stated purposes.

121-0 PLAYER SELECTION: UNKNOWN
121-1 PLAYER SELECTION: UNPAID INDIVIDUAL VOLUNTEER
121-2 PLAYER SELECTION: VOLUNTARY GROUP
121-3 PLAYER SELECTION: PAID VOLUNTEER
121-4 PLAYER SELECTION: COURSE REQUIREMENT
121-5 PLAYER SELECTION: "PROPRIETARY INTEREST ADVOCATES"

Low Middle High

Confidence Level

#122. Player Characterization: Postgraduate refers to individuals at a war college or other academic institution. #122-3 "Professional" applies to the context of the game being played; e.g., a military man playing a war game would be regarded as a professional. If he were playing a business game, he would not, in general, be regarded as a professional.

122-0 PLAYER CHARACTERIZATION: UNKNOWN
122-1 PLAYER CHARACTERIZATION: POSTGRADUATE
122-2 PLAYER CHARACTERIZATION: ADULT (NONPROFESSIONAL)
122-3 PLAYER CHARACTERIZATION: PROFESSIONAL
122-4 PLAYER CHARACTERIZATION: OTHER

Low Middle High

Confidence Level

#123. Player Use. In some man-machine exercises live players are used only because they are cheaper or more readily available than a simulated player. There is no attempt to train them nor are their goals of particular concern to the exercise. In this sense they are merely a substitute for machinery; this possibility is described in #123-0.

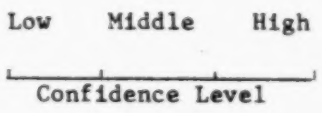
123-0 PLAYER USE: ONLY AS "MACHINERY"
123-1 PLAYER USE: AS PLAYERS

[If answer to #123 is #123-0, skip the remaining questions on players and go to #135.]

124-0 PLAYER PAYOFFS: UNKNOWN
124-1 PLAYER PAYOFFS: MONEY WAGE
124-2 PLAYER PAYOFFS: GRADES OR PAYMENT
124-3 PLAYER PAYOFFS: FIXED PRIZE
124-4 PLAYER PAYOFFS: PRIZE PROPORTIONAL TO PERFORMANCE
124-5 PLAYER PAYOFFS: "EDUCATION"
124-6 PLAYER PAYOFFS: NOT SPECIFIED

#125. Player Pretest Comprehension Test: Is a check made to see if the players fully comprehend the game prior to play? This includes the use of a practice play followed by questions.

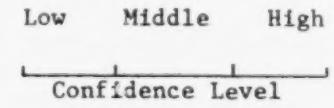
125-0 PLAYER PRETEST COMPREHENSION TEST: UNKNOWN
125-1 PLAYER PRETEST COMPREHENSION TEST: NO
125-2 PLAYER PRETEST COMPREHENSION TEST: YES



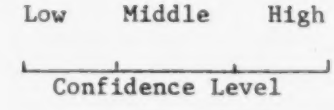
#126. Player Pretest: #126-1 refers to the case where no particular pretesting after the selection of the players has been performed; #126-2 refers to games in which one has in fact run pretests on the players. This may be a California Personality Inventory, it may be IQ-tests, and so forth. One runs subjects or players through a barrage of tests outside of the formal game.

Player pretest could be a test for IQ, general knowledge, etc., or some sort of personality test. It does not necessarily imply a comprehension test for the game.

126-0 PLAYER PRETEST: UNKNOWN
126-1 PLAYER PRETEST: NO
126-2 PLAYER PRETEST: YES (Describe)

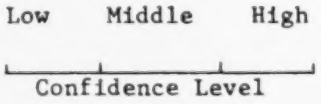


127-0 PLAYER POST PLAY COMPREHENSION CHECK: NA;UNKNOWN
127-1 PLAYER POST PLAY COMPREHENSION CHECK: NO
127-2 PLAYER POST PLAY COMPREHENSION CHECK: YES



#128. Player Perception of Success of Purpose: In this characterization we are not asking the question whether the game was effective, but how the experience was perceived by the players. A good question that must be asked of all games is, "How does enjoyment correlate with the value of a game?" It is conjectured by us that up to a certain level there is probably a positive correlation between the effectiveness of a game and the level of enjoyment or enthusiasm. Beyond a certain level, however, we suspect that the correlation weakens or goes negative. A highly enjoyable game may in fact have been enjoyed as a game and not as an operational, research, or teaching device. Informally we have observed that apparently there is not a great amount of correlation between highly popular lecturing, acting performances, and the amount of information that is conveyed to the students. In some cases player reaction may be mixed. You may wish to give a percentage breakdown next to the categories or draw a small graph.

128-0 PLAYER PERCEPTION OF SUCCESS OF PURPOSE: NOT RELEVANT; UNKNOWN
128-1 PLAYER PERCEPTION OF SUCCESS OF PURPOSE: HIGHLY POSITIVE
128-2 PLAYER PERCEPTION OF SUCCESS OF PURPOSE: POSITIVE
128-3 PLAYER PERCEPTION OF SUCCESS OF PURPOSE: NEUTRAL
128-4 PLAYER PERCEPTION OF SUCCESS OF PURPOSE: NEGATIVE
128-5 PLAYER PERCEPTION OF SUCCESS OF PURPOSE: HIGHLY NEGATIVE



129-0 "AVERAGE" PLAYER'S ENJOYMENT: NOT RELEVANT; UNKNOWN
129-1 "AVERAGE" PLAYER'S ENJOYMENT: HIGHLY POSITIVE
129-2 "AVERAGE" PLAYER'S ENJOYMENT: POSITIVE
129-3 "AVERAGE" PLAYER'S ENJOYMENT: NEUTRAL
129-4 "AVERAGE" PLAYER'S ENJOYMENT: NEGATIVE
129-5 "AVERAGE" PLAYER'S ENJOYMENT: HIGHLY NEGATIVE

#130. Number of Players Per Team: Do not fill in more than the three most frequently used categories.

130-0 NUMBER OF PLAYERS PER TEAM: (Specify)

Low Middle High

Confidence Level

131-0 REPEATED USE OF PLAYERS: NA;UNKNOWN
131-1 REPEATED USE OF PLAYERS: NO
131-2 REPEATED USE OF PLAYERS: YES

Low Middle High

Confidence Level

#132. Role Playing (Individual): #132-1 Role playing: self is the category which indicates that no other role playing is required of the players in the particular game. #132-3 Role playing: specific person implies for example that somebody play Stalin or Mao Tse-tung or Mr. Nixon. #132-4 and #132-5 A specific organization might be something like General Electric; an abstract organization would be a large business firm.

132-0 ROLE PLAYING (INDIVIDUAL): NOT RELEVANT/UNKNOWN
132-1 ROLE PLAYING (INDIVIDUAL): SELF
132-2 ROLE PLAYING (INDIVIDUAL): SPECIFIC POSITION
132-3 ROLE PLAYING (INDIVIDUAL): SPECIFIC PERSON
132-4 ROLE PLAYING (INDIVIDUAL): SPECIFIC ORGANIZATION/INSTITUTION
132-5 ROLE PLAYING (INDIVIDUAL): ABSTRACT ORGANIZATION/INSTITUTION

Low Middle High

Confidence Level

133-0 ROLE PLAYING (TEAM): NOT RELEVANT/UNKNOWN
133-1 ROLE PLAYING (TEAM): SELF
133-2 ROLE PLAYING (TEAM): SPECIFIC ORGANIZATION
133-3 ROLE PLAYING (TEAM): ABSTRACT ORGANIZATION
133-4 ROLE PLAYING (TEAM): SPECIFIC INSTITUTION
133-5 ROLE PLAYING (TEAM): ABSTRACT INSTITUIION

Low Middle High

Confidence Level

#134. Importance of Unstated Purposes: This question involves the characterization of players and what might be described as "the game outside of the game." For example, in the case of a business game where many executives from the same firm play unaccustomed roles in a simulated hierarchy, there may be pressures exerted on the individuals as a result of their being aware that they are being watched. Even in experimental games, the players sometimes may decide to play "fool the experimenter" or "give him what he wants." This question is admittedly subjective, but it merits serious consideration.

134-0 IMPORTANCE OF UNSTATED PURPOSES: NA
134-1 IMPORTANCE OF UNSTATED PURPOSES: HIGH
134-2 IMPORTANCE OF UNSTATED PURPOSES: SOMEWHAT
134-3 IMPORTANCE OF UNSTATED PURPOSES: SLIGHT
134-4 IMPORTANCE OF UNSTATED PURPOSES: NONE

Comments or Discussion:

Low Middle High
Confidence Level

#135. Game Users: Count the number of institutions where a game, simulation, or a direct variant is being used. This may tend to produce some overestimation, yet for most purposes this is the most relevant figure. It gives an insight into how widespread the direct use of a game has been or how widespread the influence of a game has been.

135-0 GAME USERS: (Specify)

Low Middle High
Confidence Level

Part IV: Voluntary Assessment

Completion of this section:

VOLAS, 4/44
Completed 74.2
Did not complete 25.8

For the remaining questions assume that a senior professional (one who really knows the business) wishes to use this MSG and wants your evaluation along several dimensions.

#136. Assessment - Design and Construction: What are the strengths and weaknesses of this MSG's design and construction?

Comment:

#137. Assessment - Planning Factors and Data: What in your opinion are the strengths, weaknesses, and constraining features of the data used in the MSG? How serious are the deficiencies or weaknesses, if any?

Comment:

#138. Assessment - Documentation: How complete and useful is the supporting documentation? Would it be easy for some other agency to use the MSG, or would the extent and quality of documentation make this difficult or impossible?

Comment:

#139. Assessment - Operation: Are there peculiarities of operation that a prospective user should be aware of? Is the MSG easy to operate, or are there unique procedural problems that one should know about?

Comment:

[For Man-Machine or Manual Games Only.]

#140. Assessment - Post Debriefing Analysis: Are the MSG's outputs easy to analyze or are they intended for use in subsequent analyses?

Comment:

#141. Assessment - Cost Effectiveness: Do you think that the MSG represents a cost-effective way to get at the issues it addresses, or would you recommend alternative procedures, methods, or techniques?

Comment:

#142. Assessment - Validation Criteria: What questions related to validation have been posed, and are they clear and concise or are they vague, confusing or non-existent? Has much attention been given to validation of the MSG?

Comment:

#143. Assessment - Validation: Based on the criteria that were developed, was any validation done on the MSG? What resulted?

Comment:

#144. Assessment - Overall: In your opinion is the MSG of outstanding, average, poor, or of indeterminate quality? Would you commend it for future use? Unqualified acceptance? Qualified?

Comment:

Appendix B

MODELS, SIMULATIONS, AND GAMES SURVEYED

FIRST VERSION OF QUESTIONNAIRE

XRAY

Inter-Nation Simulation

Business Game for Teaching and Research Purposes

SECOND VERSION OF QUESTIONNAIRE

QUICK (Quick Reacting General War Gaming System)

GO

FAST-VAL

Division Battle Model

CAIR-COMP

SIDAC (Single Integrated Damage Analysis Capability)

Supply Point Simulation Model

SIGMALOG Theater Materiel Model

TCM (Theater Combat Force Requirements Model)

LP-2 (Laboratory Problem 2)--ICBM Logistics Simulation

CARMONETTE

CASCADE III

SATAW

FINAL VERSION OF QUESTIONNAIRE

	Time Reported To Complete Questionnaire (hr)
1. LEGAL MIX IV	1
2. EFFECT 3 & 4	5
3. SMILEY	13
4. NOMOS-NOMOGRAPHS	12
5. VALUAT V	14
6. Cost Effectiveness Model	6
7. Evacuation Policy Model	3.5

		Time
8.	TAM (Target Acquisition Model)	8
9.	DYNTACS X--Small-Unit Combat Simulation	2.5
10.	HOVARM	7
11.	New Unit Cost Model, Modified	4
12.	DYNTACS (Dynamic Tactical Simulation)	3.5
13.	STANO--System Assessment Model, Phase 1 (SAM I)	8
14.	Trans-Hydro Craft	7
15.	Fire Support Simulation	5
16.	APSUB MOD 0-1	1.5
17.	CFOAM/TACOPS (Tactical Operations Model of Continuous Fleet Operations)	7
18.	APAIR	8
19.	APSURF	2.5
20.	LOTRAK II--ASW Localization Model	5
21.	ASGRAM	5
22.	Nuclear Exchange Model III	5
23.	STEM (Sub Trailing Evaluation Model)	4
24.	POSTURE	1.5
25.	SUBDUEL 1	4
26.	VERS (Vehicle and Equipment Requirements)	8
27.	SASWEM (Sub ASW Engagement Model)	15
28.	Detailed Ship Loading	6
29.	VEMPBOLT (Vehicle Mission Processor Based on Least Times)	5
30.	TATAWS	3
31.	FLAME I	13.5
32.	EXO-1	5
33.	FAIR PASS	11.5
34.	LOADER	3
35.	SPARE (Strike Planning, Aircraft Requirements Evaluator)	5
36.	SIMCAT (Simulation of Contingency Air Terminal Model)	3
37.	ATLAS	6
38.	FAME	5
39.	ASWAS (ASW Air System Model)	5
40.	ATMIX--Individual Unit Action	4

		Time
41.	CODE 50 (Navy)	3
42.	SAAB (Simulated Air-to-Air Battle)	3
43.	MARADS	9
44.	ASESEM (ASW Escort Engagement Model)	6.5
45.	SPOL (Shore Party Operation and Logistics)	4
46.	SWEM (Strategic Weapon Exchange Model)	10
47.	CAM-SAM	3.5
48.	Minefield Analysis with Hunting Evaluation Model	5
49.	STS-2 (Strip-to-Shore Model)	6
50.	SAMEN	5
51.	ORION	14
52.	LEGION	20
53.	TARTARUS IV N/COCO	16
54.	COBRA (Comprehensive Blast and Radiation Assessment System)	NR
55.	AEM (Arsenal Exchange Model)	4
56.	SINUS (Small Infantry Unit Simulator, formerly CARMONETTE)	2
57.	ETNAM	1
58.	SOAR	2
59.	TRACS	1
60.	TRAMPS	1
61.	MORG	2
62.	MACE	1
63.	THEFT	1.5
64.	Localization LASCAR	9
65.	NETWORK SIMULATOR	9.5
66.	ASWASP	8
67.	AAWSEM (Anti-Air Warfare System Effectiveness Model)	6
68.	TACOS II	32
69.	DMEW (Deterministic Mix Evaluation, Worldwide)	24
70.	GRAPHICS	32
71.	GFE III (Gross Feasibility Estimator)	14
72.	VALIMAR	NR

		Time
73.	AREA DOMINATION II	4
74.	TAR III (Target Acquisition Routine)	15
75.	FORECAST II	27
76.	TAFCOM	4
77.	SAM	4.5
78.	Air Contingency Terminal Simulator	4
79.	GIANT	8
80.	TACAIR	69
81.	OASIS - 71	28
82.	PEGASOS (Penetration Evaluation Gaming Analysis Strategic Offensive Studies)	24
83.	Advanced Penetration Model	3
84.	WEAPON	24
85.	TAC AVENGER	10
86.	COMBO--Combat Bombing Weaponeering Program	4.5
87.	MPASS	13
88.	SADDLE	19.5
89.	ATOM (Air Tactical Operations Model)	4
90.	ENDO-1	5.5
91.	"Candidate Families" Methodology: Simulation, Cost, and Optimization Models	48
92.	ATLAS (Tactical, Logistical, and Air Simulation)	40
93.	Global Distance Routine	10
94.	INFANTRY	69
95.	SPHINX II (Survival Probability Hazard in a Nuclear Exchange)	25
96.	SOUCA--Soviet Capabilities	14
97.	NEWCON	80
98.	FASTALS (Force Analysis Simulation of Theater Administrative and Logistics Support)	10
99.	SOURCE	8
100.	SDPS (Space Defense Planning Simulator)	19.5
101.	OFD (Objective Force Design)	20
102.	PFD (3-Preliminary Force Design)	13

		Time
103.	DELOGREQ (Deployment Logistics Requirements Model)	4
104.	PFD-SAM (Preliminary Force Designer Intertheater Movements Simulation)	35
105.	BOMBSIM	4
106.	UNCLE	3
107.	STAR-III	6.5
108.	OPSTRAS	NR
109.	CEM (Campaign Execution Model)	4
110.	SWIM II	3.5
111.	DIVWAG	3
112.	APSURV Model 1	2
113.	ADM (Atomic Demolition Munition)	14
114.	SEANITEOPS AGGREGATE COST MODEL	5
115.	THEATERSPIEL	8
116.	TBM (Theater Battle Model)	4
117.	TACSPIEL (Computerized)	16
118.	GLOBAL	8
119.	ADVICE II	5
120.	DIVTAG II	3
121.	DBM (Division Battle Model)	6
122.	COMMEL	40
123.	HOVER	9
124.	TEEM (TACFIRE Effectiveness Evaluation Model)	20
125.	Modified-Filter	10
126.	SUB-AIR BARRIER	4
127.	Strategic Force Mix Model	5
128.	Corps Battle Model	8
129.	SYNTAC	28
130.	APCAMP (ASW Program Campaign Model)	3.5
131.	SIRNEM	8
132.	Multi-Ship ASW Simulation	4.5
133.	VIM (Not included in evaluation)	---

Appendix C

SURVEY CODEBOOK AND LIST OF VARIABLES

Card 1:

General Class	Variable Number	Variable Name	Definition	Attributes	Column
Office		Card		Integer	1-2
Office Use		ID	Sequence number of the observation	Integer	3-5
Identification	2	MSGNME	MSG Name	Text	6-30
	7A	RESNME	Respondent's Name	Text	31-50
	7B	RESTIT	Respondent's Title	Text	51-80

Card 2:

Office		CARD		Integer	1-2
Office Use		II	Sequence number of observation	Integer	3-5
Identification	2B	DESIGN	Designing or building Agency or firm	Text	6-30
	2C	AUTHOR	Author's name of MSG	Text	31-50
	2D	SPONSR	Sponsor responsible for Initiation	Text	51-70
	2E	AGENCY	Agency ordering the work	Text	71-80

Card 3:

General Class	Variable Number	Variable Name	Definition	Attributes	Column
Office		CARD		Integer	1-2
Office Use		ID	Sequence number	Integer	3-5
	1	QT	Questionnaire Time: hours to complete questionnaire	Real number	6-9
Description	3	CATEG1	Designation of item as MSG	0 - Model 1 - Simulation 2 - Man-Machine 3 - Manual 4 - Analysis or Study 5 - Other 9 - No response	10-11*[2]
	4	RESROL1	Respondent (to questionnaire) role	0 - Funder/sponsor 1 - User 2 - Design/build 3 - Player 4 - Caretaker 5 - Control 6 - Other 9 - No response	12-14 [3]
	5	RTIME	Length of time respondent acquainted with work, expressed in months	Real Number	15-16
	10	PURP1	Major stated purpose of the work	0 - Tech. Eval. 1 - Doctrinal Eval. 2 - Force Structure 3 - PDM/IR 4 - PME/Domestic 5 - T/E 6 - Research/Method 7 - Other 9 - No Response	17-19 [3]
	10CL		Confidence level for PURP	0 - No Response 1 - Low 2 - Middle 3 - High 4 - Absolutely certain	20

*First or dominant choice goes in first column; second goes into second, etc. If only one choice, remaining columns in field are left blank. [2] = Two possibilities.

Card 3--continued

General Class	Variable Number	Variable Name	Definition	Attributes	Column
Description, cont.	11	CLASWO	Classification of MSG (without inputs)	0 - NA;Unclass. 1 - FOUO 2 - Confid. 3 - Secret 4 - TS 5 - Proprietary 6 - Other 9 - No Response	21
	12	CLASWI1	Classification of MSG when data added (highest noted first)	0 - NA;Unclass. 1 - FOUO 2 - Confid. 3 - Secret 4 - TS 5 - Proprietary 6 - Other 9 - No Response	22-23 [2]
	13A	PROREV	Has MSG been given professional external review?	0 - No 1 - Yes 9 - No Response	24
	13B	REVDAT	How many months since last professional review of MSG?	0 - Not done 1 - <6 months 2 - 6-12 months 3 - 13-24 months 4 - 25-36 months 5 - >36 months 9 - No Response	25
	14	MSGPAR	Number of MSG parents (direct)	0 - None 1 - One 2 - More than one 9 - No Response	26
	14CL		Confidence level for MSGPAR	(See Col. 20)	27
	19	MSGPRO	Number of MSG spinoffs	0 - None 1 - One 2 - More than one 9 - No response	28
	17 (17 & 18)	DEVTM1	Total time elapsed between development and initiation expressed in months	0 - <3 months 1 - 3-6 months 2 - 7-12 months 3 - 13-18 months 4 - 19-24 months 5 - 25-30 months 6 - 31-36 months 7 - 37-42 months 8 - ≥43 months 9 - No Response	29

Card 3--continued

General Class	Variable Number	Variable Name	Definition	Attributes	Column
MSG Production and Purpose	21	WHO1	Source of funds to build MSG	0 - University 1 - Foundation 2 - Private 3 - ARPA 4 - JCS 5 - USA 6 - USAF 7 - USN 8 - Other DOD 9 - Other U.S.Gov.	30-33 [4]
	22	WHODID1	Who produced MSG?	0 - Private 1 - University 2 - For profit 3 - Armed Forces 4 - Not for Profit 9 - No Response	34-35 [2]
	23	INITIA	Who initiated the model? Who was responsible for getting work underway?	0 - NA;Unknown 1 - Builders/research 2 - In house/User 3 - In house/non-user 4 - External/user 5 - External/non-user 9 - No Response	36
	24	INPURP1	What was the initiator's (Variable #23) purpose	0 - NA;Unknown 1 - Teach/Trng. 2 - Anal/Diag. 3 - Ops. 4 - Exper. 5 - Research/theory 6 - Advocacy 7 - Other 9 - No Response	37-39 [3]
	24CL		Confidence level for INPURP		40
	25	SPCPRP	How specific was funding source in designation of its purpose?	0 - NA;Unknown 1 - Tight 2 - Moderate 3 - Diffuse 9 - No Response	41
	25CL		Confidence level for SPCPRP		42
	26	ALTPRO1	Best alternative procedures to the MSG	0 - NA;Unknown 1 - None 2 - Lectures 3 - Cases/history 4 - Analysis 5 - Experience 6 - Gaming 9 - No Response	43-44 [2]

Card 3--continued

General Class	Variable Number	Variable Name	Definition	Attributes	Column
MSG Production and Purpose, cont.	27	USE1	What has been the major use of MSG? [Order with respect to #24]	Same as #24	45-47 [3]
	27CL		Confidence level for USE		48
	30	BRIEF	Number of briefings based on the MSG	0 - 0 1 - 1-3 2 - 4-6 3 - 7-9 4 - 10-12 5 - 13-15 6 - 16-18 7 - 19-21 or more 8 - Unknown 9 - No Response	49
MSG Costs to Build	35	CSTDIR	Direct costs to build	0 - <$49K 1 - 50-99K 2 - 100-249K 3 - 250-499K 4 - 500-749K 5 - 750-999K 6 - 1-2.49 Million 7 - 2.5-5 Million 8 - >5 Million 9 - NA; Unknown; No Response	50
	35CL		Confidence level for CSTDIR		51
	35A	CSTFAM	Direct costs for all in series	Same as #35	52
	35ACL		Confidence level for CSTFAM		53
	36	DIRFDS	Direct funds used to build?	0 - No 1 - Yes 9 - No Response	54
	37	FUNDIR	Direct funding to build	Same as #35	55
	37CL		Confidence level for FUNDIR		56
	38	TOTCST	Total of all types of cost to build MSG	Same as #35	57
	38CL		Confidence level for TOTCST		58
MSG Costs to Operate	39	CSTOPS	Average annual operating cost	0 - <9K 1 - 10-24K 2 - 25-49K 3 - 50-74K 4 - 75-99K 5 - >100K 9 - No Response	59

Card 3--continued

General Class	Variable Number	Variable Name	Definition	Attributes	Column
MSG Costs to Operate, cont.	39CL		Confidence level for CSTOPS		60
	40	CSTRUN	Operating cost for a single run	Same as #39	61
	41	CSTUP	Annual update costs	Same as #39	62
	41CL		Confidence-level CSTUP		63
	42	OPLIFI	Operational life span of MSG, in months	Same as #17	64
	42CL		Confidence level for OPLIFI		65
	43	ACTIVE	Still operational?	0 - No 1 - Yes 9 - No Response	66
	43CL		Confidence level for ACTIVE		67
	45	OPFRQ1	Operational use frequency per year (average)	0 - Not operational 1 - 1-5 2 - 6-10 3 - 11-15 4 - 16-20 5 - 21-25 6 - 26-50 7 - 51-100 8 - 101 or more 9 - No Response	68
	46	EXPUSE	Used for experimental purposes?	0 - No 1 - Yes 9 - No Response	69
	48	EXPRP	Was the MSG intended to be used experimentally?	Same as above	70
	49	EDUSE	Used for educational purposes?	Same as above	71
	51	EDPRO	Was the MSG intended to be used educationally?	Same as above	72
	52	TRANSU	Level of difficulty of transferal of MSG	0 - Not for transfer 1 - Generally 2 - Moderate 3 - Middling 4 - Difficult 5 - Extreme 9 - No response	73

Card 3--continued

General Class	Variable Number	Variable Name	Definition	Attributes	Column
MSG Costs to Operate, cont.	53	TRANSC	Transfer costs to operate	0 - NA;Unknown 1 - Cost 2 - +10% 3 - +10-25% 4 - +25-50% 5 - +50-100% 6 - >100%	74
	53CL		Confidence level for TRANSC		75
	55	DUPMSG	Is there an MSG that serves same purpose?	0 - No 1 - Yes 9 - No Response	76
Recommendations Opinions	57	CLEAR	Clearinghouse utility	0 - Highly useful 1 - Useful 2 - Same 3 - Harmful 4 - Highly harmful 9 - No Response	77
	58	STNPD1	Standardization's utility	0 - Highly useful 1 - Useful 2 - Same 3 - Harmful 4 - Highly Harmful 9 - No Response	78
	59	REGCEN	Operation utility of regional center [coded from verbal response]	Same as above	79
	60	EXREV	Opinion on utility of external review board [coded from verbal response]	Same as above	80

Card 4:

General Class	Variable Number	Variable Name	Definition	Attributes	Column
Office		CARD		Integer	1-2
Office Use		ID	Sequence number	Integer	3-5
MSG Characterization and Description (Technical)		RES2	Is the technical section filled out by same person as the initial segment	0 - No 1 - Yes	*
	62	SCENATP	Scenario type of MSG	0 - Numerical 1 - Verbal for use 2 - Verbal for Analysis 9 - No Response	7
	64	MATHS	Mathematical level of sophistication of MSG	0 - None 1 - Slight 2 - Moderate 3 - High 9 - No Response	8
	65	MODEL	"Clock" used to sequence MSG moves	0 - NA/Unknown 1 - Event 2 - Fixed 3 - Combination 1&2 9 - No Response	9
	66	MT/RT	Model time to real time ratio	0 - NA/Unknown 1 - Highly compressed 2 - Compressed 3 - Real Time 4 - Expanded 5 - Highly expanded 9 - No Response	10
	roll		Confidence level for MT/RT		11
	67	TIME	Time represented in MSG	0 - Past 1 - Present 2 - Future 3 - Unspecified 4 - Not relevant 5 - Combination of above 9 - No Response	12

Card 4--continued

General Class	Variable Number	Variable Name	Definition	Attributes	Column
MSG Characterization and Description, cont.	68	LRTIME	Level of resolution, model time, smallest unit	0 - NA;Unknown 1 - Seconds 2 - Minutes 3 - Hours 4 - Days 5 - Weeks 6 - Quarters 7 - Years 8 - >Years 9 - No Response	13
	69	LRSPCE	Level of resolution, smallest model spatial count of analysis	0 - NA;Unknown 1 - Meters 2 - Kilometers 3 - Theater/continent 4 - Varied 9 - No response	14
	69CL		Confidence Level for LRSPCE		15
	70	LRSIDE	Level of resolution, sides in MSG	0 - NA;Unknown 1 - Individuals 2 - Small groups(struct.) 3 - Small orgs. 4 - Large orgs. 5 - Very large orgs. 6 - Small groups(unstruct.) 9 - No Response	16
	71	LRMIL	Level of resolution, military action	0 - NA;Unknown 1 - Engagement 2 - Battle 3 - Campaign 4 - War 5 - Diplomatic	17
	71CL		Confidence level for LRMIL		18
	72	RNDM	Are random events considered?	0 - No 1 - Yes 9 - No Response	19
MSG Planning Factors and data	73	DATAS	Where did data come from?	0 - NA;Unknown 1 - Military/not cross-checked 2 - Military/cross-checked 3 - Civil 4 - Generated own 5 - Field exercise 6 - Combination of above 9 - No Response	20

Card 4--continued

General Class	Variable Number	Variable Name	Definition	Attributes	Column
MSG Planning Factors and Data, cont.	78	SENSET	Was sensitivity analysis done?	0 - No 1 - Yes 9 - No Response	21
	80	LATAV	Who validated the data, how well [coded from text]	0 - NA,Unknown 1 - High quality 2 - Moderate 3 - Weak 4 - Not done 9 - No Response	22
	82	LANG	What language is MSG written in?	0 - NA 1 - FORTRAN 2 - PL-1 3 - COBOL 4 - GPSS 5 - SIMSCRIPT 6 - ALGOL 7 - ASSEMBLER 8 - Other 9 - No Response	23
	82CL		Confidence level for LANG		24
	83	MSGSIZ	How many computer instructions (1000's)?	0 - NA Unknown 1 - <1000 2 - 1-2K 3 - 2-4K 4 - 4-6K 5 - 6-8K 6 - 8-10K 7 - >10K 9 - No Response	25
	84	FACIL	Special facilities needed for MSG	0 - NA,Unknown 1 - Special building 2 - Dedicated computer (unclas.) 3 - Dedicated computer (classified) 4 - Special language, library, or system 9 - No Response	26
	84CL		Confidence level for FACIL		27
MSG Production costs	85	DEVTM2	Development time, in months	Same as #17	28
	85CL		Confidence level for DEVTM2		29
	86	DEVMY?	Total man years in development	0 - NA;Unknown 1 - 0-1 2 - 2-5 3 - 6-10 4 - 11-20 5 - >20 9 - No Response	30

Card 4--continued

General Class	Variable Number	Variable Name	Definition	Attributes	Column
MSG Production Costs, cont.	86CL		Confidence level for DEVMY1		31
	87	DVPMY1	Total professional man-years in development	Same as #86	32
	88CL		Confidence level for DVPMY1		33
	89	DVPRG1	Total programmer man-years in development	Same as #86	34
MSG Documentation	90	DOCEXT	Extent of documentation, general assessment	0 - NA;Zero:Unknown 1 - Excellent 2 - VG 3 - Average 4 - Weak 5 - Poor 6 - Uneven/variable 7 - Unavailable 8 - Combinations of above 9 - No Response	35
	91	DOCLOC	Where is the documentation located?	0 - NA;Unknown 1 - Out of print/Unk. 2 - Proprietary /NFP 3 - Proprietary/Commercial 4 - Proprietary/Author 5 - Prop.(Class.)/Author 6 - Public/Doc 7 - Public/Loc 8 - Public/Journals, books 9 - No Response	36-38 [3]
	93	DOCPUB	Publication type of documentation	0 - Books/articles 1 - User manual 2 - Program deck 3 - Reports 4 - 0 & 1 5 - 1 & 2 6 - Other combinations 9 - No Response	39
echnical ecommendations/ pinions	95	TECH	Technical coordination opinion	0 - Highly undesirable 1 - Undesirable 2 - Indifferent 3 - Desirable 4 - Highly desirable / - No Response	40

Card 4--continued

General Class	Variable Number	Variable Name	Definition	Attributes	Column
Technical Recommendations, cont.	96	STNRD2	Standards Committee [coded from verbal text]	Same as #58	41
Questionnaire Evaluation	97	QUEVAL	Respondent evaluation of questionnaire	0 - Excellent 1 - Good 2 - Modal 3 - Poor 4 - Bad 9 - No response	42
	98	IQC	Researchers' assessment of the quality of the questionnaire responses	Same as above	43
	136	VOLAS	Did the respondent provide information in the voluntary assessment portion of the questionnaire?	0 - No 1 - Yes	44
Types of data	74	DATAT	Types of data	0 - NA;Unknown 1 - Type 1 only 2 - Type 2 only 3 - Type 3 only 4 - Types 1 and 2 5 - Types 1 and 3 6 - Types 2 and 3 7 - All Types 9 - No response	45
Intangibles: Assumptions made or utilized	77	INTASP	Intangibles: Assumptions Made in Model	0 - No 1 - Yes 2 - Could not determine 9 - No response	46
Service		SERVIC	Service Using the MSG	1 - USA 2 - USAF 3 - USN 4 - Other DOD	47
Use Date	18	USEDAT	USE initiation date	0 - Never operated 1 - <57 2 - 58-59 3 - 60-61 4 - 62-63 5 - 64-65 6 - 66-67 7 - 68-70 8 - 71-72 9 - NA, Unknown, No response	48

Card 5:

General Class	Variable Number	Variable Name	Definition	Attributes	Column
Office		Card		Integer	1-2
Office Use		ID	Sequence number of the observation	Integer	3-5
Production Costs	35$	CSTDR$	Direct costs to build (1000's)	Real	6-10
	35A$	CSTFM$	Direct costs to build family of models (1000's)	Real	11-15
	37$	FUNDR$	Direct funding to build (1000's)	Real	16-20
	38$	TOT$	Total of all types of costs to build MSG (1000's)	Real	21-25
Operational Costs	39$	CSTOP$	Average annual operating costs (1000's)	Real	26-30
	40$	CSTRN$	Cost per single run (1000's)	Real	31-35
	41$	CSTUP$	Annual update costs (1000's)	Real	36-40
	42R	OPLIF2	Number of months MSG operational	Integer	41-42
	45R	OPFRQ2	Number of times (total) MSG has been run for any 5 years	Integer	43-45
Data Requirements/ Size	75A	INCON	Number of input constants	Integer	46-48
	75B	INPAR	Number of input parameters	Integer	49-51
	75C	INVAR	Number of input variables	Integer	52-54
	76	OUTVAR	Number of output variables	Integer	55-57
Development Time	85R	DEVTM3	Number of months MSG under development	Integer	58-59
	86R	DEVMY2	Number of total man-years under development	Integer	60-63
	87R	DVPMY2	Number of professional man-years under development	Integer	64-67
	89R	DVPRG2	Number of programmer man-years under development	Integer	68-71

Cards 6-12 (narrative descriptions):

General Class	Variable Number	Variable Name	Definition	Attributes	Column
Card 6:					
Office		Card		Integer	1-2
Office use		ID	Sequence number of the observation	Integer	3-5
Purpose	4	PURPS	Verbal summary of specific purposes	Hollerith	6-40
Card 7:					
Office		Card		Integer	1-2
Office		ID	Sequence number of the observation	Integer	3-5
Antecedents/ Spinoffs	14	ANTEC	Names of antecedents	Hollerith	6-40
	15	SPIN	Names of spinoffs	Hollerith	41-80
Card 8:					
Office		Card		Integer	1-2
Office		ID	Sequence number of the observation	Integer	3-5
Benefits/ Use	31	BFIEF	Who was briefed?	Hollerith	6-40
	32	PRPBRF	What was the specific purpose of the briefing?	Hollerith	41-80
Card 9:					
Office		Card		Integer	1-2
Office		ID	Sequence number of the observation	Integer	3-5
	33	IMPBRF	Importance of the MSG to decisions	Hollerith	6-40
	34	BNFIT	Criteria listed as benefits for having used this particular MSG	Hollerith	

Cards 6-12--continued

General Class	Variable Number	Variable Name	Definition	Attributes	Column
Card 10:					
Office		Card		Integer	1-2
Office		ID	Sequence number of the observation	Integer	3-5
	44	USERS	Who uses the MSG at this time?	Hollerith	6-40
	54	OBSOL	Estimated speed at which respondent thinks the model will become obsolete; reasons for this, if noted	Hollerith	41-80
Card 11:					
Office		Card		Integer	1-2
Office		ID	Sequence number of the observation	Integer	3-5
Data	73A	DATV1	Sources of the data used in the MSG	Hollerith	6-40
	80A	DATV2	Procedures used to validate the data	Hollerith	41-80
Card 12:					
Office		Card		Integer	1-2
Office		ID	Sequence number of the observation	Integer	3-5
Languages/ Machinery	81	LANGS	Languages used to code this MSG	Hollerith	6-40
	82A	COMPS	Computers on which this MSG is (has been) run	Hollerith	41-80